JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

MANABU TAGOMORI
DAN T. KOCHI

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

REF:WRM-KO

DEC 10 1991

Mr. Maurice A. Richard
Puna Geothermal Venture
101 Aupuni Street, Ste. 1014-B
Hilo, Hawaii 96720

Dear Mr. Richard:

Approval of Puna Geothermal Venture's Amended Plan of Operations

The Department of Land and Natural Resources hereby approves the following documents amending Puna Geothermal Venture's Plan of Operations:

1. "Proposed Modification to the Puna Geothermal Venture Plan of Operations, December 1988" and "Appendix B (revised); Puna Geothermal Venture Development Well Drilling Program." (October 2, 1991)

2. "Puna Geothermal Venture (PGV) Proposed Amendment to Plan of Operations: 1) drilling sequence and schedule; and 2) confidential geologic modeling of the PGV geothermal resource." (October 24, 1991)

3. "Puna Geothermal Venture (PGV) Plan of Operations - changes in PGV's drilling procedures and supervision." (October 31, 1991)

4. "Puna Geothermal Venture Plan of Operations (POO) - revision to earlier POO amendment of October 2, 1991." (November 1, 1991)

5. "PGV Plan of Operations Noise Addendum", as amended and approved by the Department of Health. (December 9, 1991)

We have reviewed the above documents and have no objections to the amended Plan of Operations. Please be advised that individual drilling and casing programs for each well must be submitted to DLNR for review and approval prior to commencement of any drilling operations. Should you have any questions, please contact Manabu Tagomori at 587-0214.

Very truly yours,

WILLIAM W. PATY

PUNA GEOTHERMAL VENTURE

A Hawaii Partnership

October 2, 1991

Mr. William Paty
Director
State Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Attached please find the following two documents: "Proposed Modifications to the Puna Geothermal Venture Plan of Operation, December 1988," and "Appendix B (Revised); Puna Geothermal Venture Development Well Drilling Program."

The proposed modifications are consistent with the "Independent Technical Investigation of the Puna Geothermal Venture Unplanned Steam Release, June 12 and 13, 1991, Puna, Hawaii" dated July, 1991. Both documents will amend the Plan of Operations for the Puna Geothermal Venture (PGV) project which was approved on March 10, 1989, and amended on May 23, 1991.

We believe the proposed changes to the Plan of Operations requires your approval and PGV is prepared to adhere to, and execute, the Plan as submitted herein.

Please feel free to call me should you or your staff want to discuss the merits or content of this submittal. I may be reached in Hilo at 961-2184. Your continued assistance is sincerely appreciated.

Sincerely,

Maurice A. Richard
Vice President
Puna Geothermal Venture

Attachments

cc:
M. Tagamori w/attachments
D. Nakano w/attachments

91128.021

101 Aupuni Street, Suite 1014-B, Hilo, Hawaii 96720 • (808) 961-2184 • Facsimile (808) 961-3531

PROPOSED MODIFICATIONS TO THE
PUNA GEOTHERMAL VENTURE
PLAN OF OPERATION
DECEMBER, 1988

1. INTRODUCTION

The Independent Technical Investigation of the Puna Geothermal Venture Unplanned Steam Release, June 12 and 13, 1991, Puna, Hawaii (Element I) contains recommendations for modifications and additions to the basic Puna Geothermal Venture (PGV) drilling program as described in the Geothermal Resource Permit Application Amendment for the Puna Geothermal Venture Project, December, 1988. This permit application is the Plan of Operation (POO) for PGV as approved by the Hawaii Department of Land and Natural Resources (DLNR). In order for PGV to implement the recommendations of Element I, PGV must request and receive approval for modifications to the POO from DLNR. The purpose of this document is to describe those changes to the POO that will be implemented by PGV as recommended in Element I. The format followed in this document uses, as a reference designation, the page and paragraph of the item to be modified in the POO. The proposed changes to the POO are then described immediately following each reference.

2. PROPOSED MODIFICATIONS

2.1 Modification A

Reference:

POO: Section 3.2.1.2 Well Drilling

Add the following text at end of section:

Appropriate drilling personnel training and supervision are vital to the safety of drilling operations in high temperature geothermal environments like that found in the PGV resource area. PGV will execute the following training and supervision policies during drilling operations:

* Two company supervisors will work equal time on and off to provide closer supervision of all drilling activities.

* Drilling rig supervisory personnel will be on the rig floor during crew changes and all critical drilling operations.

* All blowout prevention (BOP) drills and blowout prevention equipment (BOPE) operations will be entered in the International Association of Drilling Contractors (IADC) tour reports.

* All toolpushers, drillers, derrickmen, and supervisors will be trained in the use of monitoring and alarm systems.

* All drilling personnel will be trained to recognize changes in drilling functions and subsurface conditions that may indicate proximity to, or penetration of, geothermal production zones.

* Criteria and procedures will be established for all drilling personnel to communicate significant changes in subsurface conditions to supervisors and regulators.

* Standard drilling orders have been formulated and will be followed during all operations to provide for safe operating procedures.

2.2 Modification B

Reference:

POO: Section 3.2.1.2 Well Drilling, Page 20, Paragraph 2

Replace Paragraph 2 with the following text:

All wells will be drilled into the geothermal resource, which may start at depths ranging from 1,600 feet to 4,000 feet below surface. Wells drilled as production wells will consist of 20-inch, 13-3/8-inch, and 9-5/8-inch diameter casings. The 20-inch casing provides hole stability and reduces the loss of drilling mud into fractures from the surface to a depth of 1,000 to 1,200 feet. The 13-3/8-inch casing will extend from the surface down to low permeability rock below the deepest Underground Source of Drinking Water (USDW). This casing string will typically be set in the 1,200 to 2,000 foot depth interval and cemented to the surface. The 9-5/8-inch casing will be set and cemented from the surface to near the top of the reservoir. The final choice of casing points for each casing string will be determined during drilling. The data used to make the casing point determinations may include but shall not be limited to the following:

* Rock stability and strength as determined by rate of penetration, sloughing, and washouts.

* Permeability as determined by rate of drilling fluid loss.

* Mineralogy indicating increased temperature, hydrothermal alteration, and mineral deposition.

* Increased formation temperature as determined by mud return temperature and periodic temperature surveys and measurement.

* Increased formation fluid pressure above normal ground water hydrostatic head as indicated by flow from the well with mud pumps shut off or increase in drilling fluid volume not accounted for by addition of drilling water.

* Influx of gases, primarily hydrogen sulfide and carbon dioxide, into the drilling fluid as determined by surface gas monitors on flow line.

* Loss of circulation below the depth of normal ground water occurrence.

* Drilling records and geotechnical data from adjacent wells.

Figure 3.3 is a diagram of a typical production well and Appendix B is a typical development well drilling and completion program.

Replace Appendix B with the attached revised drilling program labeled Appendix B (Revised).

2.3 Modification C

Reference:

POO: Section 3.2.1.2 Well Drilling

Add the following text before first complete paragraph, page 22:

The hole drilled for the surface casing (typically a 26-inch hole for 20-inch diameter casing) is drilled without blow out prevention equipment. During the drilling of the surface hole

below a depth of 500 feet, the following precautions will be taken to prevent encountering geothermal resource without the BOPE installed:

* Run maximum reading thermometers with directional survey at each stand (approximately 93 feet) to detect abnormal increases in formation or fluid temperature.

* Monitor circulating fluid returns for abnormal increases in salinity, conductivity or chloride content.

* Catch cutting samples every 10 feet and analyze them for the presence of hydrothermal minerals.

In the event that proximity to a geothermal zone is indicated, DLNR will be notified and operator will request to run and cement surface casing and install BOPE.

2.4 Modification D

Reference:

POO: Section 3.2.1.2 Well Drilling, Page 23

Add the following text at the end of Section 3.2.1.2 text, page 23:

When drilling above the production zone, a sudden release (well kick) of high pressure steam, gas, and fluid may occur. The BOPE and wellhead installed on the 13-3/8-inch casing will be designed and rated to handle such kicks. The BOPE will include a large diameter flow relief port which during normal drilling operations will be sealed with a low pressure burst plate. In the event of a kick, the burst plate will rupture, thereby diverting the initial high pressure pulse into a large diameter relief line. A muffler and abatement system will be installed on the relief line to minimize hydrogen sulfide emissions and noise until the flow is shut in. Details of the wellhead, BOPE and flow relief equipment are shown in Appendix B (Revised).

Control of high pressure, high temperature geothermal zones during drilling will require a high-volume drilling fluid system. The system will include a high volume water well for the continuous supply of drilling water. The mud system will be of sufficient volume to allow the mixing and storage of heavy mud required for pressure control of the well. Mud

cooling capacity will be installed that is adequate to maintain mud temperatures at levels that are both safe for drilling personnel and sufficiently low to maintain proper mud properties.

Drilling personnel and supervisors will be provided with monitors of drilling functions and conditions that provide an indication of proximity to or penetration into a geothermal production zone. The monitors will include an alarm system. The alarm levels for each function will be included in the Standard Drilling Orders. The monitoring system will include the following functions:

* Hydrogen sulfide and carbon dioxide
* Mud return temperature
* Pump pressure
* Rotary table torque
* Rate of penetration
* Weight on bit
* Pit volume

2.5 Modification E

Reference:

POO: Section 3.8 Geologic Report, Page 66, Paragraph 1

Add the following text at the end of Paragraph 1, page 66:

The conceptual geologic model described in Section 3.8, "Geologic Report," will change from time to time as the Project develops and new geologic data becomes available from drilling and other geoscientific studies. The geologic model revisions will be made available to DLNR in the form of confidential reports, as warranted by the proprietary data presented therein.

Change Page 68, line 8, the word "600°F" to "665°F".

APPENDIX B (REVISED)

PUNA GEOTHERMAL VENTURE
DEVELOPMENT WELL DRILLING PROGRAM

WELL LOCATION AND LAYOUT (See Figure 1, 3)

CONDUCTOR CASING AND CELLAR:

Set a 30-inch conductor pipe in a 42-inch hole that is drilled to a depth of 50 feet below ground level. Cement the conductor in place with a Type II Portland concrete cement placed down the backside of the 30-inch conductor pipe.

Following the setting of the conductor pipe, dig a 12-feet-by-12-feet-by-11-feet earthen cellar and construct reinforced concrete cellar according to the civil contractor's design and specifications (Figure 2).

DRILLING 26-INCH HOLE:

Rig up a suitable drilling rig as shown in Figure 3. Weld on 30-inch pitcher nipple. Spud in with 26-inch bit. Anticipate losing total returns at any time below surface. Continue drilling ahead on water, aerated mud or foam without returns. Run maximum reading thermometers during directional surveys every 90 feet below a depth of 500 feet. Drill to a depth of 650 feet.

At this depth, rig up bailer and bail continuously or as required to get a representative ground water sample. Collect samples and send to lab for analysis. Have State witness sampling procedure. Notify State 24 hours prior to taking samples.

Resume drilling 26-inch hole on water, aerated mud, or foam. Drill to a depth of ±1000 feet, the casing point for 20-inch casing. If abnormal temperatures are encountered, notify the drilling superintendent and stop drilling. The 20-inch casing may be set at that point after consulting with and receiving permission from Department of Land and Natural Resources (DLNR).

SURFACE CASING:

Approximately 1,000 feet of 20-inch 94# K55 BT&C casing will be run and cemented in place. Run casing while filling on every second joint.

Cement 20-inch casing through drill pipe with Type II + 40% silica flour + 2% calcium chloride + 0.65% CFR-3. Excess is calculated at 100%. Reciprocate casing 10 to 15 feet throughout job.

Wait on cement for 12 hours. Have at least 200 cubic yards of sand, gravel, and/or volcanic cinders on hand.

Pick up and run 1-inch tubing down backside of 20-inch casing. Tag fill. Mix and pump Type II cement + 40% silica flour + 2% calcium chloride + 0.65% CFR-3. Circulate to surface. Pull tubing and wash shield laying down. Wait on cement for 12 hours. Should the cement settle, top out with batched ready-mix poured down the backside of the 20-inch casing. Ready-mix can be accelerated with 2% by weight of calcium chloride. Wait on cement for 12 hours.

BLOWOUT PREVENTION EQUIPMENT (BOPE) - 17-1/2-INCH HOLE (Figure 5):

Cut off casing and weld on 20-inch - 2M slip on casinghead with two side outlets. Valve the outlets with 3-inch - 2M RTJ gate valves.

Blowout prevention equipment to drill a 17-1/2-inch hole should consist of a 20-inch - 2000# double gate preventer and a 21-1/4-inch - 2M MSP Hydril Type Annular Preventer, choke and kill lines. Test BOPE per State requirements and note test results in IADC tour report and morning report. Notify appropriate State regulatory agencies 24 hours prior to testing.

DRILLING 17-1/2-INCH HOLE:

Drill out from underneath the 20-inch surface casing with mud, a 17-1/2-inch mill tooth bit, and slick bottomhole assembly. Drill out and trip for bottomhole assembly.

Should lost circulation persist, loss interval(s) should be cemented.

The 17-1/2-inch hole is to be drilled to a depth of ±2,000 feet where the 13-3/8-inch casing is to be run.

INTERMEDIATE CASING:

Approximately 2,000 feet of 13-3/8-inch 61# K55 NEW VAM casing is to be run and cemented in place in a single stage.

Cement with Type II cement + 40% silica flour + 0.65% CFR-3. If losses are encountered below the 20-inch casing shoe, it may be advisable to cement the 13-3/8-inch string with a light weight spherlite cement slurry tailed by 200 sacks of Type II slurry. Pump 60% excess.

BLOWOUT PREVENTION EQUIPMENT - 12-1/4-INCH HOLE (Figure 6):

Cut off casing and install 13-3/8-inch by 13-5/8-inch - 5M casinghead. Blowout prevention equipment to drill a 12-1/4-inch hole will consist of two 13-5/8-inch - 5M double gate preventers, a 13-5/8-inch - 5M Hydril annular preventer, a banjo box with rupture disk and single gate preventer on the side outlet, a rotating drilling head, choke, and kill line. Test BOPE per State requirements and note test results in IADC tour report and morning report. Notify appropriate State regulatory agencies 24 hours prior to testing (see Figure 6). Install blooie line and muffler. Install hydrogen sulfide abatement equipment on blooie line (Figure 10).

DRILLING 12-1/4-INCH HOLE:

Drill out the shoe with a 12-1/4-inch bit and slick bottomhole assembly. Conduct leak-off test by pressuring well to the equivalent to 11#/gal fluid. Squeeze if required. Trip for bottomhole assembly. Drill to casing point at ±3,900 feet.

PRODUCTION CASING:

Approximately 3,900 feet of 9-5/8-inch 47# C90 NEW VAM casing is to be run and cemented. Cement casing Type II cement + 40% silica flour + 50 lb/sk of spherlite + 4% gel + 1.25% CFR-3 + 1.5% HALAD 22A. Excess is calculated at 60%. After WOC, cut off the 9-5/8-inch casing. Dress casing 8 inches above casinghead flange with 27-1/2° chamfer. Nipple up 13-5/8-inch - 5M x 10-inch - 5M Type S WKM Expansion Spool with packing sleeve.

BLOWOUT PREVENTION EQUIPMENT 8-1/2-INCH HOLE (Figure 7):

Blowout prevention equipment to drill the 8-1/2-inch section of hole should consist of a 10-inch - 5M WKM gate valve, 10-inch - 5M by 13-5/8-inch - 5M DSA, two 13-5/8-inch - 5M double gate preventers, a 13-5/8-inch - 5M Hydril annular preventer, a banjo box, a rotating drilling head, choke, and kill line. Test BOPE per State requirements and note test results in IADC tour report and morning report. Notify appropriate State regulatory agencies 24 hours prior to testing. Install hydrogen sulfide abatement equipment and muffler on choke line.

DRILLING 8-1/2-INCH HOLE:

Drill out from underneath the 9-5/8-inch casing on water with an 8-1/2-inch bit and slick bottomhole assembly. Perform leakoff test and squeeze if required. Trip for packed BHA and continue drilling ahead on mud.

Should differential sticking occur, rig up the air compressor with the degasser to free the stuck string.

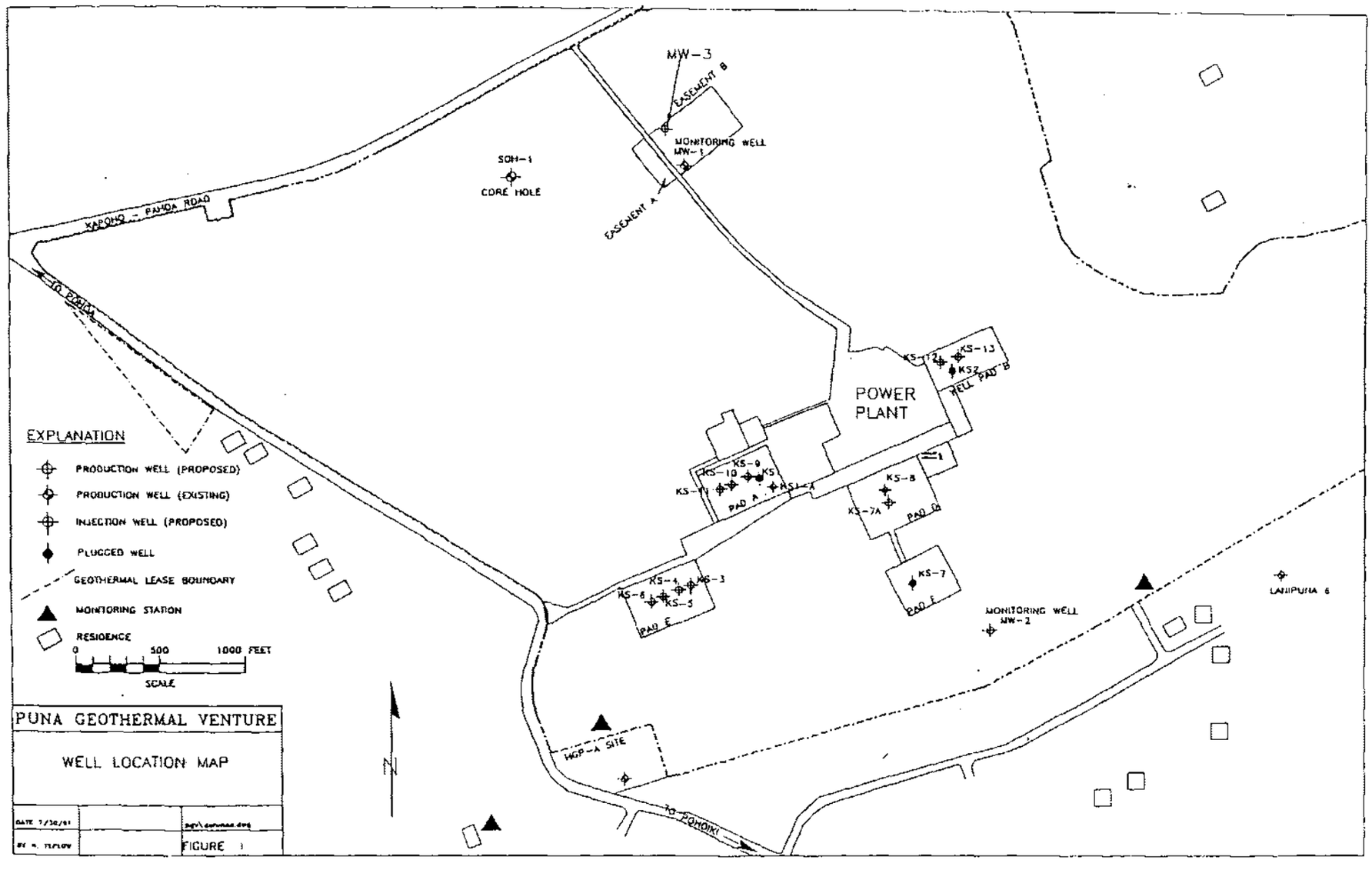
At ±7,400 feet TVD circulate out mud with fresh water. Trip-out of hole and rig up flow test. If test is successful, run production liner if required.

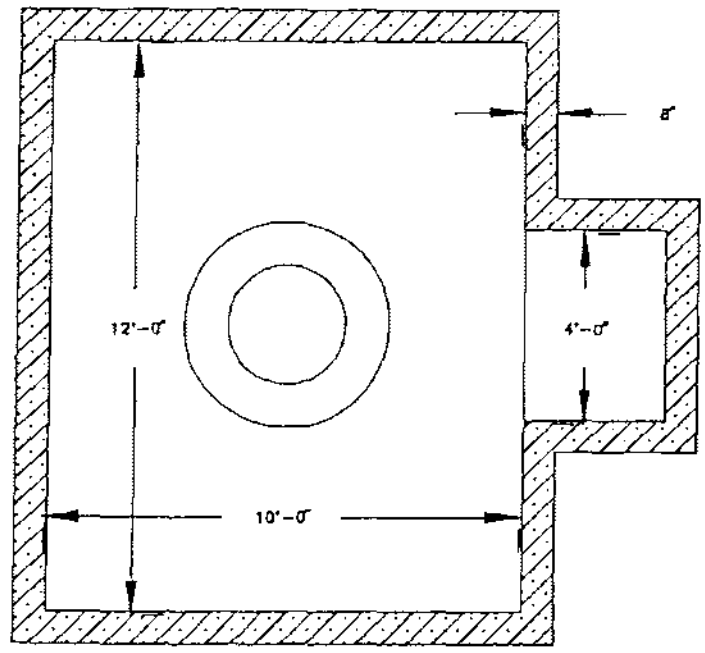
PRODUCTION LINER:

Trip in hole with slick BHA and check for fill. If hole is opened, run approximately 3,800 feet of 7-inch 29# L80 BT&C casing slotted with 1/4-inch by 2-inch slots on 12 row pattern. Run liner with cement guide shoe on bottom and hang on 7-inch by 9-5/8-inch single slip cone type liner hanger. Release from hanger and trip out laying down.

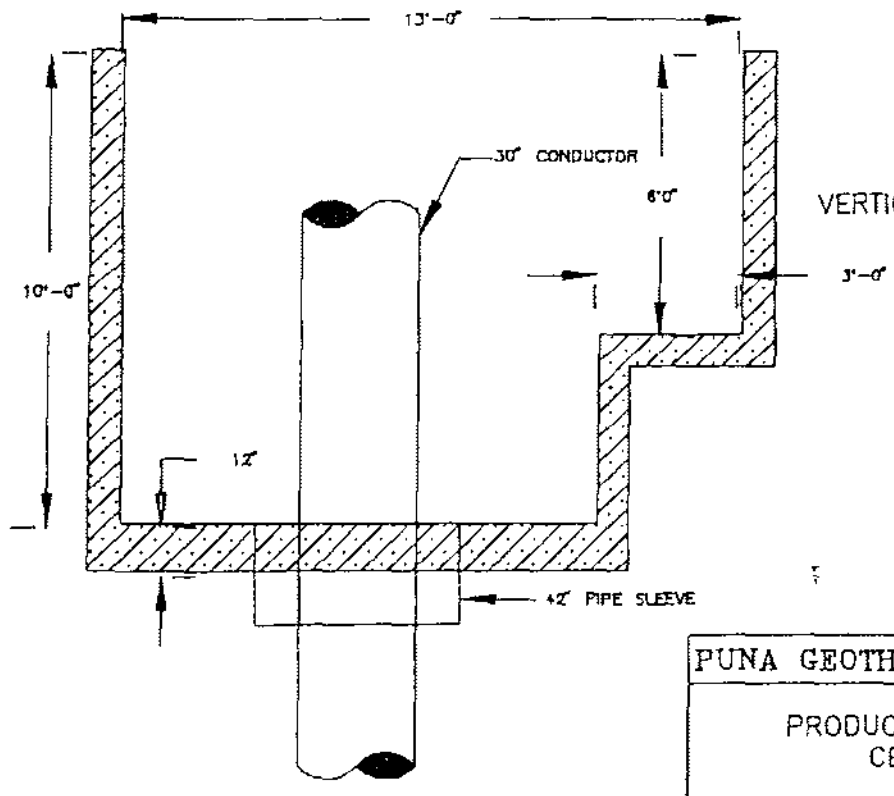
Nipple down BOP and install final wellhead for production well as show in Figure 8.

If well is to be used for injection, an optional 7-inch injection liner may be installed. Run approximately 3,700 feet of 7-inch 29# SM-22 New Vam casing and hang on donut type hanger set in top of 10-inch by 13-5/8-inch expansion spool (Figure 9).


MW-3
EASEMENT B
MONITORING WELL MW-1
SOH-1
CORE HOLE
EASEMENT A
KAPOHO - PAHOA ROAD
TO PAHOA
POWER PLANT
KS-12
KS-13
KS-2
WELL PAD B
KS-9
KS-10
KS-11
KS-1
PAD A
KS-8
KS-7A
PAD D
KS-7
PAD F
KS-4
KS-3
KS-6
KS-5
PAD E
MONITORING WELL MW-2
LANIPUNA 6
HGP-A SITE
TO POHOIKI
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
PLUGGED WELL
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
N
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
DATE 7/30/91
FIGURE 1



PLAN

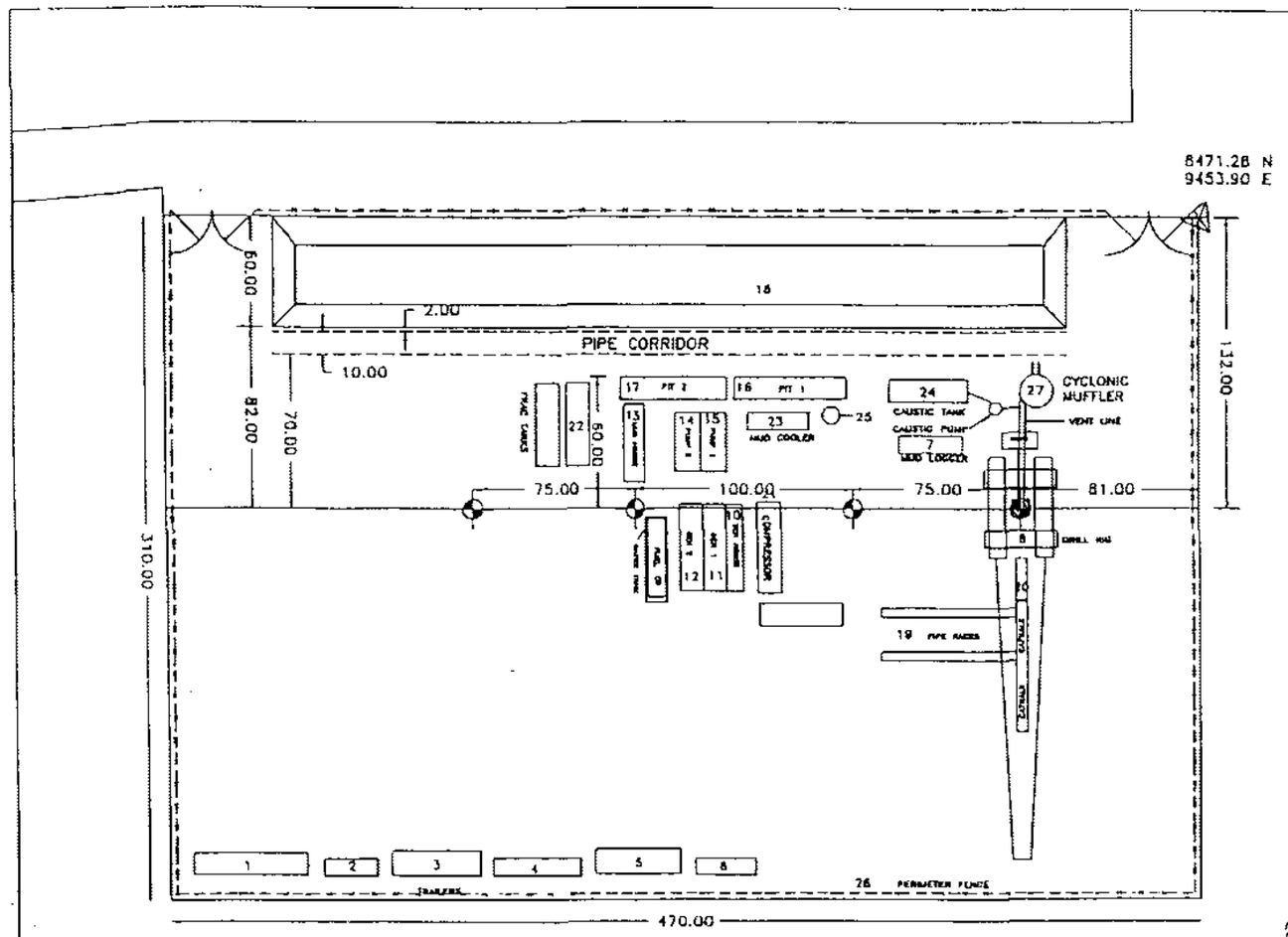


VERTICAL SECTION

PUNA GEOTHERMAL VENTURE

PRODUCTION WELL
CELLAR

DATE 3/12/86	SCALE 1" = 4'	file: pgv\cellar.dwg
BY W. TEPLOW		FIGURE NO. 2



EQUIPMENT LIST

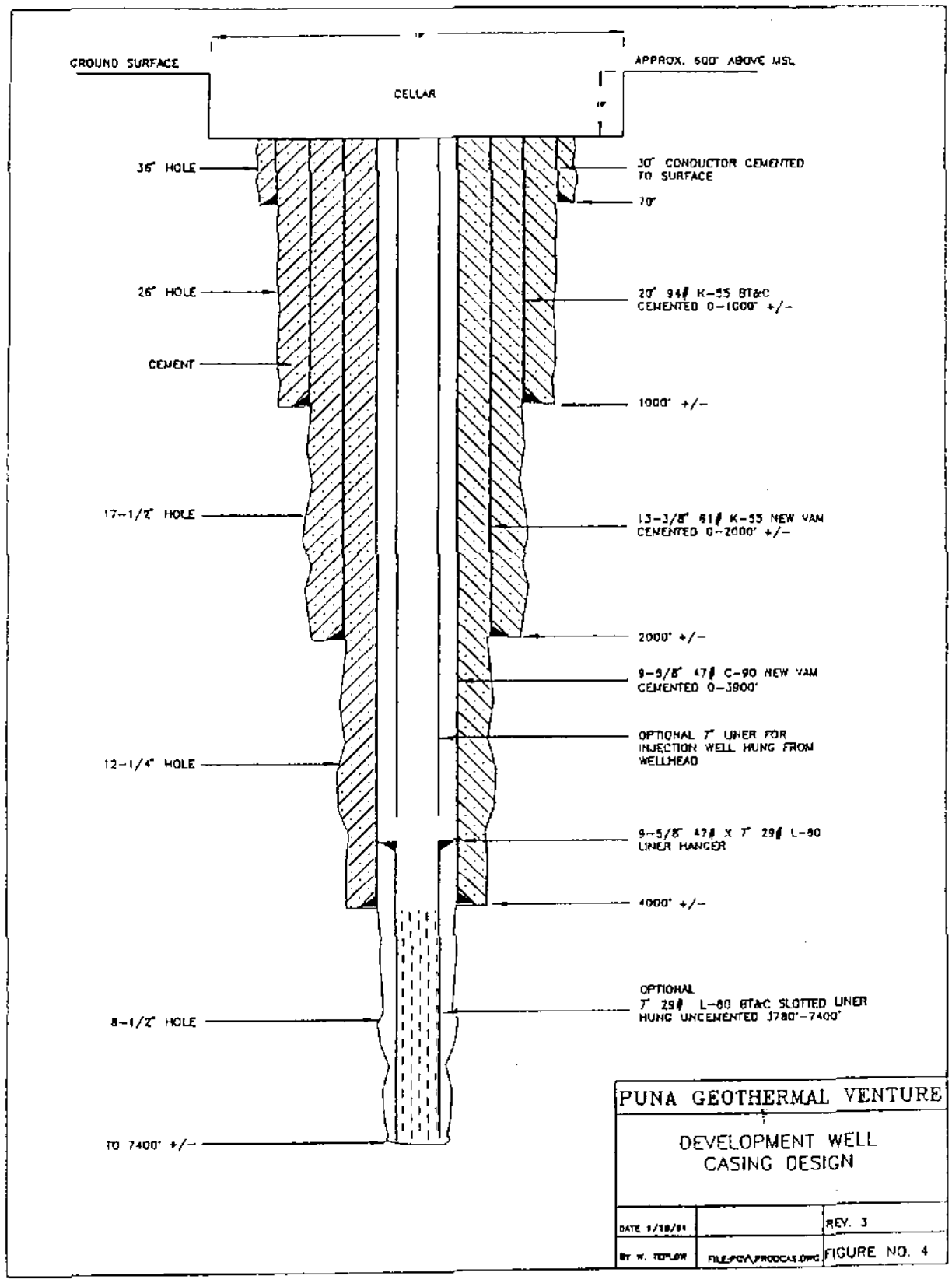
ITEM	HEIGHT (FT)
1. GEOLOGIST TRAILER	14.0
2. DIRECTIONAL SERVICES	12.0
3. AIR SERVICES	12.0
4. TOOL PUSHER	12.0
5. DRILLING SUPERINTENDENT	14.0
6. MUD SERVICES	12.0
7. MUD LOGGER	12.0
8. DRILL RIG	168.0
9. WATER TANK\FUEL TANK	20.0
10. SCR HOUSE	10.5
11. GENERATOR #1	10.7
12. GENERATOR #2	10.7
13. MUD HOUSE	9.4
14. MUD PUMP #1	10.5
15. MUD PUMP #2	10.5
16. MUD TANK #1	4.4
17. MUD TANK #2	4.4
18. RESERVE PIT	-10.0
19. PIPE RACKS (2)	8.7
20. CATWALK	4.4
21. AIR COMPRESSOR	20.0
22. FRAC TANKS (4)	14.0
23. MUD COOLER	24.1
24. CAUSTIC TANK	14.0
25. DEGASSER	20.0
26. PERIMETER FENCE	7.0
27. CYCLONIC MUFFLER	15.0

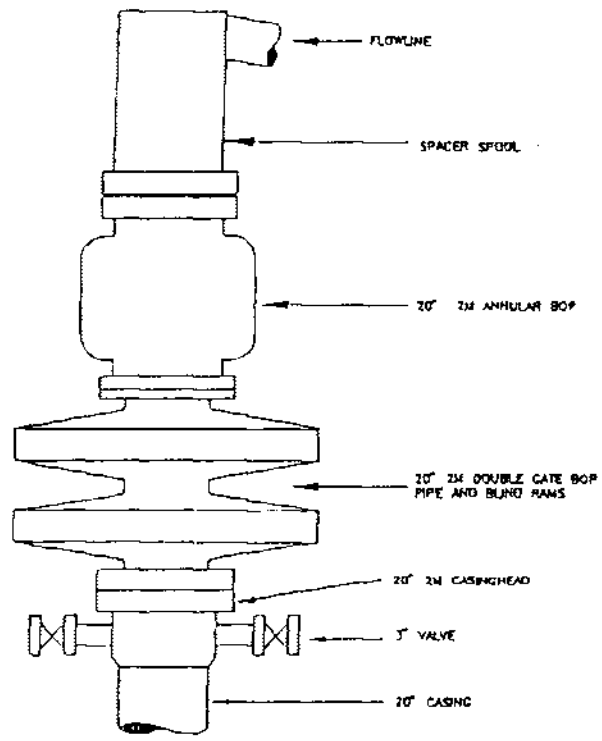
0 50 100 FEET
SCALE

PUNA GEOTHERMAL VENTURE

TYPICAL DEVELOPMENT
WELL RIG LAYOUT

REV. 9/27/91		FILE: PGV\WELPAD
BY: M. TEPLOW		FIGURE NO. 3

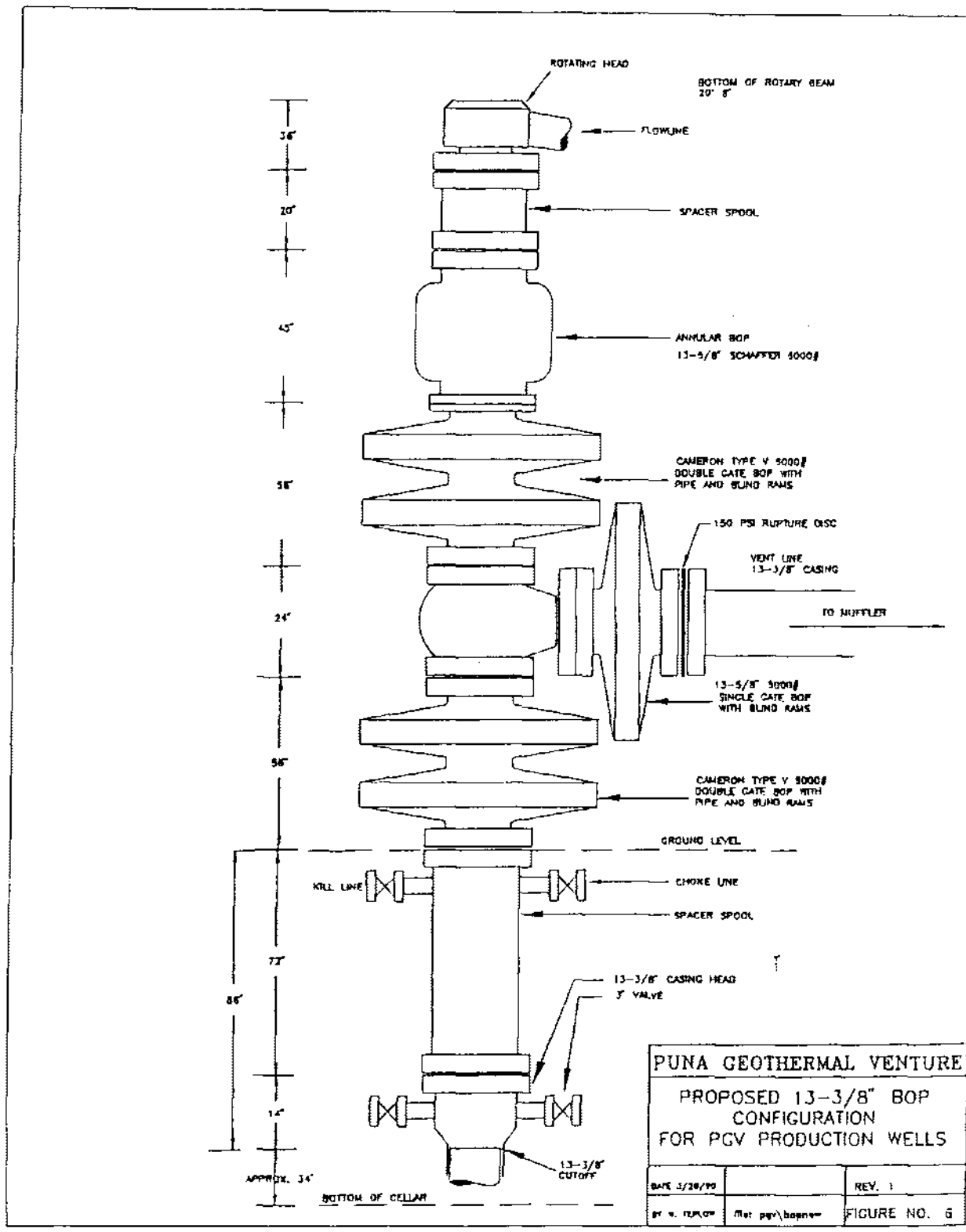

GROUND SURFACE
CELLAR
APPROX. 600' ABOVE MSL
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# K-55 BT&C CEMENTED 0-1000' +/-
CEMENT
1000' +/-
17-1/2" HOLE
13-3/8" 61# K-55 NEW VAM CEMENTED 0-2000' +/-
2000' +/-
9-5/8" 47# C-90 NEW VAM CEMENTED 0-3900'
OPTIONAL 7" LINER FOR INJECTION WELL HUNG FROM WELLHEAD
12-1/4" HOLE
9-5/8" 47# X 7" 29# L-80 LINER HANGER
4000' +/-
OPTIONAL
7" 29# L-80 BT&C SLOTTED LINER HUNG UNCEMENTED 3780'-7400'
8-1/2" HOLE
TO 7400' +/-
PUNA GEOTHERMAL VENTURE
DEVELOPMENT WELL
CASING DESIGN
DATE 9/18/91
REV. 3
BY W. TOPLOW
FILE:PGV\PRODCAS.DWG
FIGURE NO. 4



PUNA GEOTHERMAL VENTURE

20" BOP
CONFIGURATION
FOR PGV DEVELOPMENT WELLS

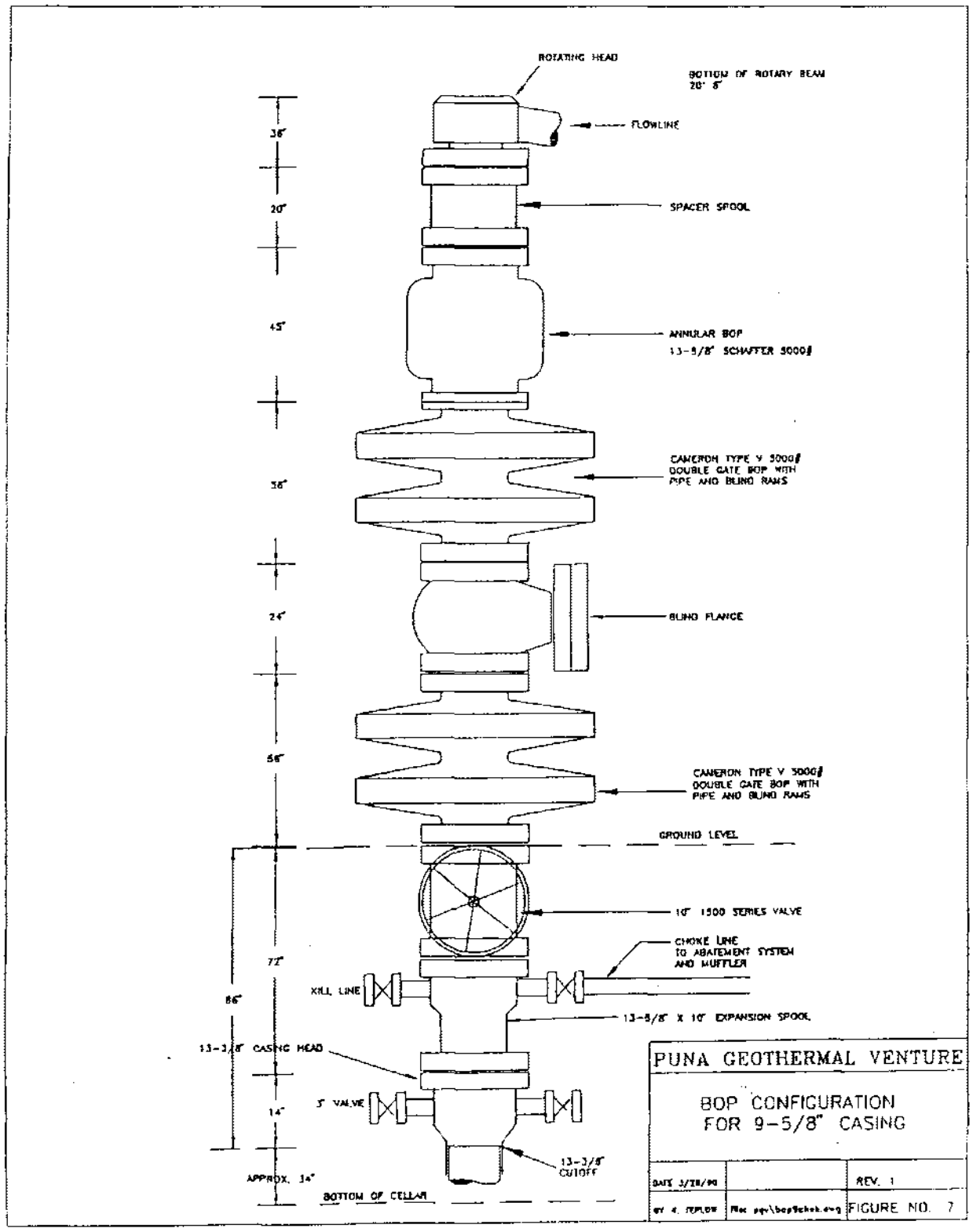
DATE 1/15/90		REV. 1
BY M. TEPLOW	files pgv\bop20new	FIGURE NO. 5



PUNA GEOTHERMAL VENTURE

PROPOSED 13-3/8" BOP
CONFIGURATION
FOR PGV PRODUCTION WELLS

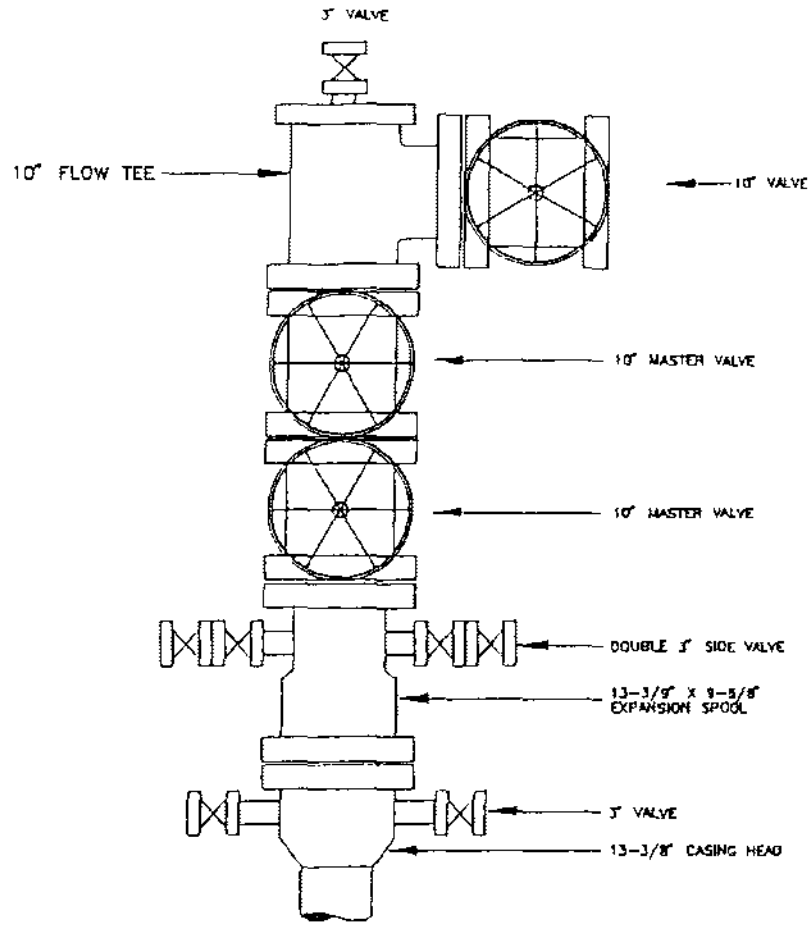
DATE 3/20/90		REV. 1
BY W. TEMPLE	file: pgv\bopnew	FIGURE NO. 6



PUNA GEOTHERMAL VENTURE

BOP CONFIGURATION
FOR 9-5/8" CASING

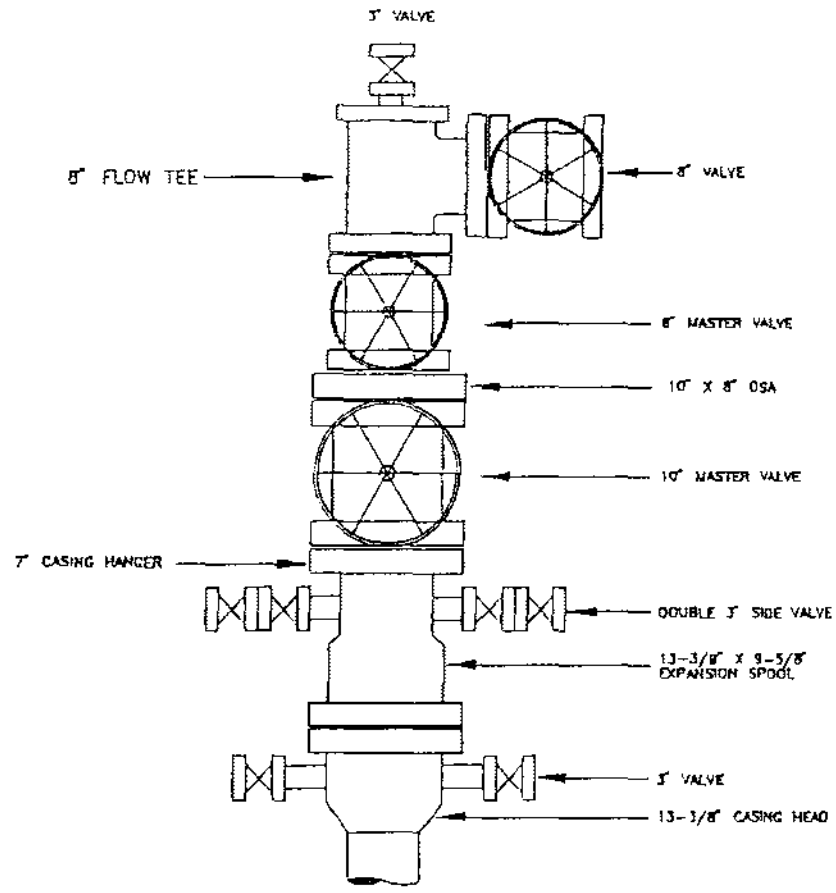
DATE 3/28/90		REV. 1
BY A. TAYLOR	Mac pgv\bop9chok.dwg	FIGURE NO. 7



PUNA GEOTHERMAL VENTURE

PRODUCTION WELLHEAD CONFIGURATION

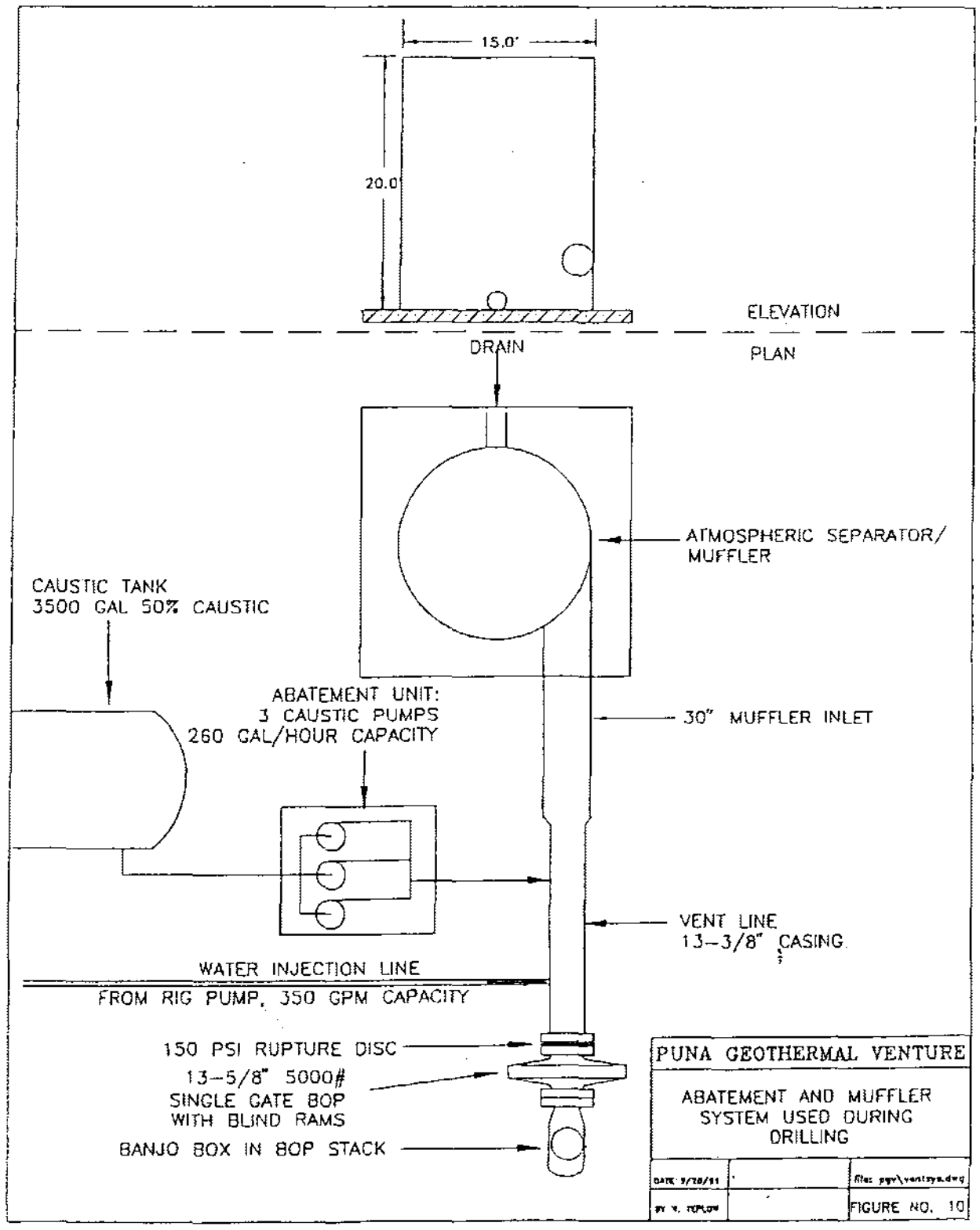
DATE 3/29/90		REV. 1
BY W. TERUYA		FIGURE NO. 8



PUNA GEOTHERMAL VENTURE

INJECTION WELLHEAD CONFIGURATION

DATE 9/23/91	file: pgv\injectwh.dwg	REV. 1
BY W. TEPLOW		FIGURE NO. 9


15.0'
20.0
ELEVATION
PLAN
DRAIN
ATMOSPHERIC SEPARATOR/
MUFFLER
CAUSTIC TANK
3500 GAL 50% CAUSTIC
ABATEMENT UNIT:
3 CAUSTIC PUMPS
260 GAL/HOUR CAPACITY
30" MUFFLER INLET
VENT LINE
13-3/8" CASING
WATER INJECTION LINE
FROM RIG PUMP, 350 GPM CAPACITY
150 PSI RUPTURE DISC
13-5/8" 5000#
SINGLE GATE BOP
WITH BLIND RAMS
BANJO BOX IN BOP STACK
PUNA GEOTHERMAL VENTURE
ABATEMENT AND MUFFLER
SYSTEM USED DURING
DRILLING
FIGURE NO. 10

PUNA GEOTHERMAL VENTURE

A Hawaii Partnership

HAND DELIVER

October 24, 1991

Mr. William Paty
Director
State Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: Puna Geothermal Venture (PGV)
Proposed Amendment to Plan of Operations

Attached please find, for your review and approval, PGV's proposed amendment to the Plan of Operations regarding the following two aspects of the geothermal field development: 1) drilling sequence and schedule; and 2) geologic modeling of the PGV geothermal resource. This amendment is consistent with the recommendations presented in the Geothermal Management Plan, issued on October 4, 1991, by the joint State and County Task Force.

Puna Geothermal Venture is currently completing the noise analysis and will submit this document for your review upon completion. Subsequently, PGV will submit the following documents: 1) revised drilling application for KS-8; and 2) a revised casing and testing program for KS-3 for approval. Future submittals will be made as appropriate to the project.

If you have any questions regarding this submittal or any future applications, please feel free to contact me in the Hilo office at 961-2184.

Sincerely,

Maurice A. Richard
Vice President
Puna Geothermal Venture

Attachment

91151.011

101 Aupuni Street, Suite 1014-B, Hilo, Hawaii 96720 • (808) 961-2184 • Facsimile (808) 961-3531

HDROGEOLOGIC MODEL OF THE PUNA GEOTHERMAL VENTURE GEOTHERMAL RESOURCE UPDATE OCTOBER 22, 1991

EXECUTIVE SUMMARY

1. The Puna Geothermal Venture (PGV) geothermal resource lies entirely within the Lower East Rift Zone (LERZ). The LERZ is a 1-2 mile wide, volcanically and tectonicaly active zone characterized by frequent basaltic eruptions and widespread tensional fracturing.

2. Puna Geothermal Venture (PGV) and other operators have drilled nine deep exploration into and adjacent to the PGV geothermal resource.

3. Drilling, testing, and long-term commercial production from the deep wells have confirmed the existence of a significant commercial geothermal resource.

4. The commercial resource is characterized by two distinct reservoir types: 1) a pervasive, low transmissivity, high temperature reservoir; and 2) high transmissivity zones contained within steeply dipping fractures.

5. The low transmissivity reservoir underlies much of the PGV project site at depths below 5000 feet. The reservoir is capable of sustaining commercial production in the range of 60 thousand pounds per hour (kph) steam per well which is equivalent to 3 megawatts of net electrical generation per well.

6. Wells drilled into the low transmissivity reservoir also exhibit good injection characteristics. Two to three wells drilled into the reservoir will provide injection capacity for the 25 MW power plant effluent stream.

7. The high transmissivity zone, as encountered by production well KS-8, appears to provide very high productivity, possibly in excess of 200 kph steam per well (10 MW electric per well).

8. Based on the current reservoir model, PGV production wells will be targeted to intersect the KS-8 fracture at depths below 3500 feet. Injection wells will be targeted to the low transmissivity reservoir as stepouts from the injection zone defined by KS-3.

9. Thermal breakthrough from injection zones to production zones is not expected to occur because of the diffuse nature and low transmissivity of the fracture system in the injection zone.

10. Non-condensable gas breakthrough is not expected because the gas will be highly undersaturated in the injection zone and will not be concentrated above natural reservoir dissolved gas levels by the power conversion cycle prior to injection.

PUNA GEOTHERMAL VENTURE
PROPOSED AMENDMENT TO PLAN OF OPERATIONS

I. DRILLING SEQUENCE AND SCHEDULE:

Upon the reinstatement of the drilling permits (suspended as a result of the June 12, 1991, uncontrolled flow event at KS-8), PGV proposes the following sequence of drilling and field development activities:

1. Complete and test production well KS-8 using Parker Rig #231.

2. Perform injection test and casing integrity program on KS-1A. Place in service as injection well.

3. Move Parker Rig #231 to KS-3 and complete well modification and testing required to covert well into an injection well.

4. Move Parker Rig #231 to KS-4 and drill an injection well.

5. Move Parker Rig #231 to KS-9 and drill a production well.

6. Move Parker Rig #231 to a development well location, to be determined by previous drilling data, and drill an injection or production well, as required by the project.

7. Move Parker Rig #231 to KS-7 and perform a well evaluation for possible plug and abandonment.

Well locations are shown on Figure 1. The sequence and schedule described above is shown in Figure 2 as they relate to the power plant startup. The power plant startup will commence upon the completion of the KS-3 conversion to an injection well. This is expected to take place approximately 35 days after reinstatement of the drilling permits.

The schedule and drilling sequence described above may be further modified in the event that two drill rigs are used simultaneously. The use of a second drill rig is dependent upon meeting environmental standards and operational safety requirements put forth by the Hawaii Department of Health (HDOH) and the Hawaii Department of Land and Natural Resources (DLNR). In the event that a second rig is allowed, an additional development well will be drilled at the KS-11 site immediately

upon receipt of agency authorization. The well can be targeted either as an injection or production well, depending upon the previous drilling and testing data and the need to provide redundant injection capacity in a timely manner.

II. GEOLOGIC MODEL

The PGV geologic staff updates the geologic model of the PGV geothermal resource from time to time as significant new data is gathered from drilling and testing operations and ongoing geotechnical studies. This updated model is provided to DLNR as part of the revision to the Plan of Operations. This is done so that the DLNR staff has an current geologic basis for making regulatory decisions related to drilling and wellfield operations. Attachment A contains the updated geologic model for the PGV geothermal resource. The model incorporates all drilling data and geotechnical studies available to date to the PGV staff. This attachment contains data and analyses which PGV considers to be proprietary and strictly confidential. Puna Geothermal Venture is making this information available to DLNR with the understanding that the document will be maintained in strictest confidence for the internal use of the DLNR and HDOH staff only.

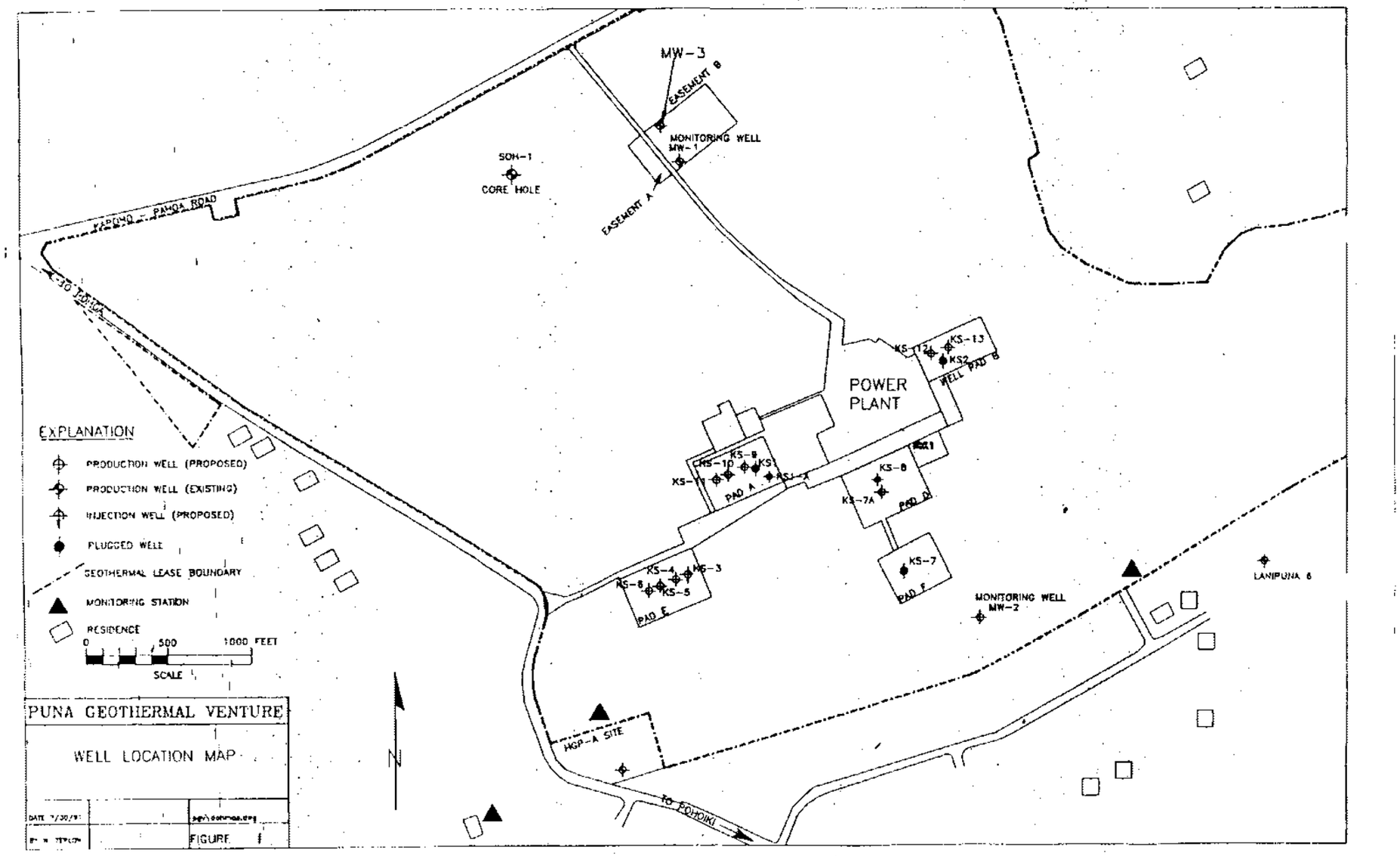
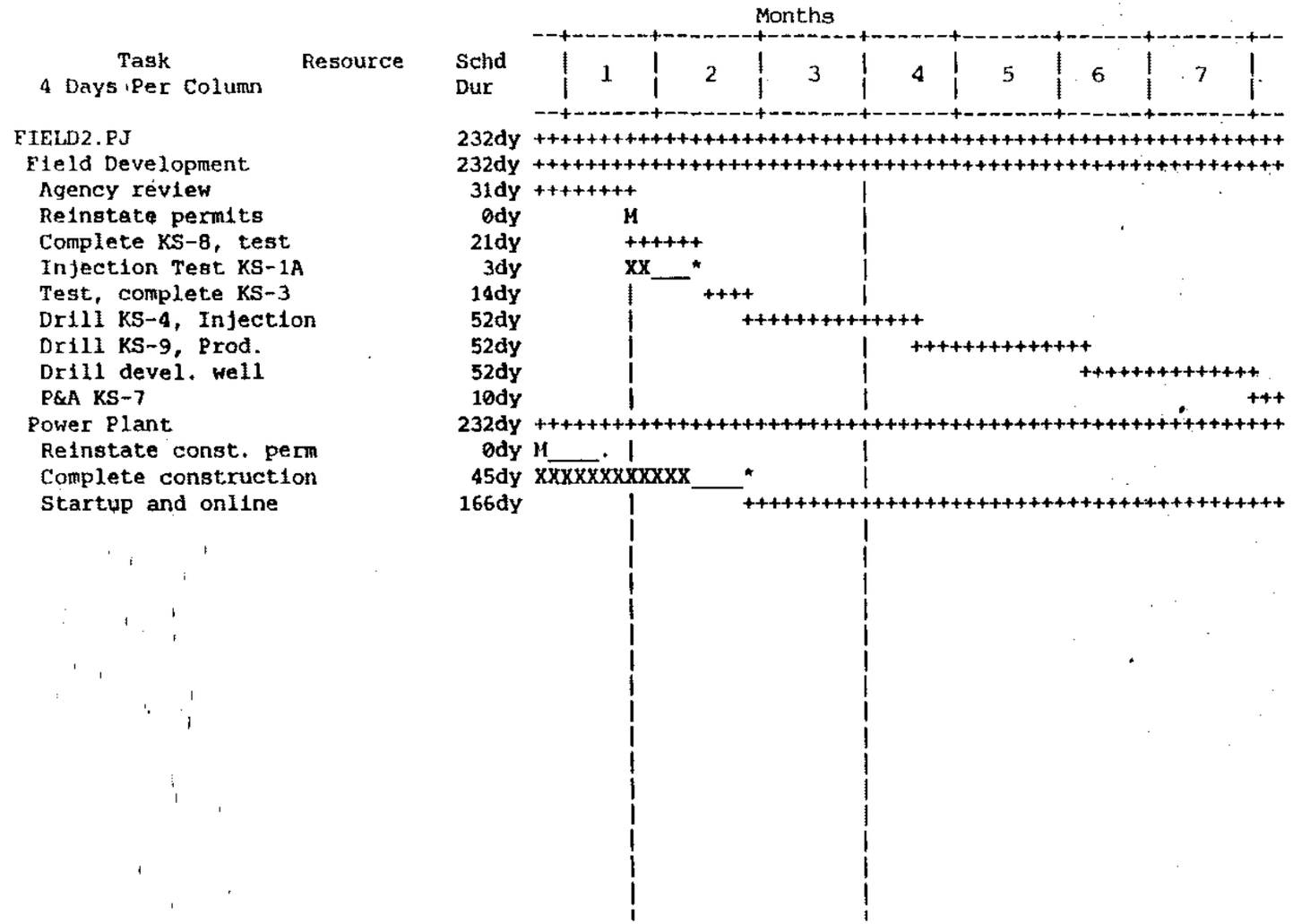

MW-3
EASEMENT B
MONITORING WELL MW-1
SOH-1
CORE HOLE
EASEMENT A
KAPOHO - PAHOA ROAD
TO HILO
POWER PLANT
KS-12
KS-13
KS2
WELL PAD B
KS-9
KS-10
KS1
KS-11
KS-1
PAD A
KS-8
KS-7A
PAD D
KS-7
PAD F
KS-4
KS-3
KS-6
KS-5
PAD E
MONITORING WELL MW-2
LANIPUNA 6
HGP-A SITE
TO POHOIKI
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
PLUGGED WELL
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
N
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
DATE 7/30/91
FIGURE 1

Figure 2

GENERAL
10-23-91 11:00p

PGV FIELD DEVELOPMENT SCHEDULE, ONE RIG



Cover
PUNA GEOTHERMAL VENTURE
A Hawaii Partnership

October 31, 1991

Mr. William Paty
Chairman
State Department of Land and Natural
Resources
P.O. Box 621
Honolulu, Hawaii 96801

Dear Mr. Paty:

Re: Puna Geothermal Venture (PGV) Plan of Operations

Thank you for your letter dated October 4, 1991, restating the intent of the Geothermal Management Plan, Element I, "Changes in PGV's Drilling Procedures and Supervision."

The attached response addresses all the points raised in your letter using the same numerical system found in your October 4, 1991 letter. PGV feels this response fulfills the Element I requirement of the Geothermal Management Plan.

In addition to addressing the Geothermal Management Plan, PGV requests this submittal also be considered as a formal amendment to the PGV Plan of Operations.

On October 24, 1991, PGV submitted a proposed amendment to the Plan of Operations that included a (1) drilling sequence and schedule; and (2) geologic modeling of the PGV geothermal resource which includes the requested injection strategy.

PGV anticipates the submittal of the following applications or documentation to your office:

1. Revised noise plan.

2. Revision to the October 2, 1991, amendment to the Plan of Operations. The revision will address and incorporate the recommendations found in Element I of the Geothermal Management Plan.

3. Testing program for KS-8 well.

91163.011

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4. Injection program and casing integrity program for KS-1A well.

5. Well modification and testing procedures for KS-3 well.

6. Drilling program and testing program for KS-4 well.

If there are any questions, please feel free to contact me in the Hilo office at 961-2184.

Sincerely,

Maurice A. Richard
Vice President
Puna Geothermal Venture

Attachment

cc:
B. Anderson, DOH
M. Tagamori, DLNR

91163.011

PUNA GEOTHERMAL VENTURE
RESPONSE TO GEOTHERMAL MANAGEMENT PLAN
ELEMENT I

1. The driller will be the supervisor on the rig floor during all drilling operations. The contractor's supervisor will be on the floor during all crew changes to ensure continuity of floor supervision. During critical operations, the contractor's and/or operator's supervisor will also be on the rig floor. The driller has available direct communications with both the contractor's and the operator's supervisors. The driller will have additional supervision anytime he needs it or sees a condition that may require more attention.

   PGV will have two drilling supervisors assigned working an equal time schedule. The drilling contractor will provide an additional mechanic/electrician to relieve the rig supervisors from some of the duties they have been responsible for. The contractors rig supervisors also work an equal time schedule and do not work more than three days in a row. These changes will allow the supervisors to provide closer supervision.

   The IADC Tour Sheet will be signed daily by the three drillers on shift, the contractor's supervisor and the operator's supervisor. Copies of the tour sheets will be sent to the Department of Land and Natural Resources (DLNR). DLNR representatives are free to check the rig floor at any time by informing the contractor's and operator's supervisor that they are going to the floor.

2. Periodic blowout prevention drills will be conducted and noted in the IADC tour reports. All personnel will receive training in BOPE operations. DLNR field personnel will be informed of the dates and times of this training and may participate in the training. Training shall consist of providing copies of the University of Texas Petroleum Extension Service, Blowout Prevention Manual. The manual will be discussed during safety meetings with the operator's supervisor. Tests will be given to all personnel to ensure that the material is understood.

3. All tool pushers, drillers, and derrickmen will be trained in the use of monitoring equipment, and this training will be noted in the IADC tour reports. DLNR field personnel will be informed of the dates and times of this training and may participate in the training. Training shall consist of informal classes in the use of the Drillers Assistant Monitoring System by TECTON GEOLOGIC personnel using the Operators Manual which will be distributed. The class will

cover equipment specifications and operating instructions. Tests will be given to ensure that the material is understood. The class will be given periodically as part of pre-spud operations.

4. All supervisory drilling personnel will be trained to understand the implications of changes in subsurface conditions, such as pit level changes, pump pressure changes and rate of penetration indicated by the monitoring equipment. This training will be noted in the IADC tour reports. DLNR field personnel will be informed of the dates and times of this training and may participate in the training. Training shall be included in the TECTON GEOLOGICAL Class on monitoring equipment operations. The significance of the surface changes on subsurface conditions will be discussed. The possible subsurface causes of the surface changes and their significance in the drilling operations will be pointed out.

   PGV will provide a Well Control School tailored to geothermal drilling conditions for all supervisory personnel. This school will be similar to the Well Control Course for MMS Certification and will include: 1. Pressure/Pressure Gradient, 2. Well Kicks, 3. Shut-In Procedures, 4. Circulating Out-Kicks, 5. Equipment, 6. Well Design, 7. Special Operations, 8. Common Mistakes in Well Control, and 9. Organizing and Directing Well Control.

5. PGV has establish reporting criteria for subsurface conditions (attached) and will instruct all drilling personnel to communicate significant changes in subsurface conditions to supervisors. Examples of some of these conditions are: 1. Trip Gas/Bottoms-Up Vapor, 2. Mud Pit Level Changes, 3. Flow Line Temperature Changes, 4. Rate of Penetration Changes, 5. Pump Pressure Changes, 6. Gas Detection, 7. Mud Property Changes, 8. Formation Changes, and 9. Bottom Hole Temperature Changes. When changes in subsurface conditions will significantly affect the drilling procedure or casing program, the DLNR field representative will be informed by the operator's supervisor.

6. PGV will henceforth take a conservative, flexible approach to casing the well above 2,000 feet. Drilling and casing programs will be submitted for approval on a well by well basis. Any changes will be made and approved as set forth in point 10.

7. When drilling below 500 feet without BOPE, PGV will:
   a. Run maximum reading thermometers at each stand drilled looking for increases in thermal gradient.
   b. Take a representative water sample and have it analyzed as soon as possible to determine salinity and conductivity.
   c. Catch 10 foot samples and analyze them for hydrothermal alteration when there are returns to surface. We will attempt to maintain returns whenever possible.
   d. Monitor circulating fluid returns for abnormal increase in salinity, conductivity, or chloride content.
   e. If it appears that a geothermal zone is to be encountered, secure DLNR approval, run casing, cement, and rig up BOPE.

8. PGV will:
   a. Install a large relief valve from the 13-5/8-inch BOPE stack.
   b. Install a low-pressure burst plate in the flow relief line (to divert the flow).
   c. Include an additional double-gate preventer in the 13-5/8-inch BOPE stack with variable pipe rams.
   d. Install a muffler on the large diverter line,
   e. Equip mud pumps with the maximum appropriate sized pump liners.
   f. Provide an adequate cool water supply on site to control the well.
   g. Provide a larger, more efficient mud cooler. The more efficient mud cooler will provide up to 50% more cooling when the mud flowline temperature is in the 125°F to 150°F range. PGV may use two coolers if PGV encounters mud temperatures that indicate the need for two coolers.

h. Drilling personnel and supervisors will be provided with monitors of drilling functions and conditions. The monitors will include an alarm system. The monitoring system will include the following functions: 1. Hydrogen sulfide levels, 2. Pump pressure, 3. Rotary table torque, 4. Rate of penetration, 5. Weight on bit, and 6. Pit volume.

9. PGV acknowledges that the Department of Land and Natural Resources is now the lead State regulatory agency with regard to oversight and control of both production and injection wells. Plans and modifications for the drilling of all currently permitted and any future proposed geothermal wells will be revised in accordance with these plan amendments, and will be directed to the Department of Land and Natural Resources for approval before any operations take place.

10. The following mechanism is proposed whereby PGV may propose and the Department of Land and Natural Resources may approve, on-site modifications to casing programs or drilling operations.

    PGV supervisors will discuss on-site modifications to casing or drilling operations with the DLNR field representative. After these discussions, the DLNR field representative will contact his supervisor and provide a detailed explanation of the proposed changes. After discussions with his supervisor, the DLNR field representative and/or his immediate supervisor shall have the authority to provide PGV with a verbal approval immediately for any modifications. PGV will submit a written sundry notice of the approved changes as soon as possible.

11. PGV has provided DLNR with Appendix B (Revised) as a generic development well drilling program. It is acknowledged, however, that specific revised casing programs will be provided for each well, for those already permitted and for those proposed to be drilled, based on total knowledge accumulated on all the wells.

12. The first confidential report will be made available to DLNR before December 31, 1991, and shall contain a comparison and analysis of differences between PGV's earlier conceptual geologic model. The model will be updated to DLNR when it is significantly modified.

Further, PGV will ensure that the Plan of Operations Appendix "B", Development Well Drilling Program, conforms to the recommendations of the Independent Technical Investigation, Element I. This will be done by including the following changes in Appendix "B":

A) Page 2 - Blowout Prevention Equipment (20-inch BOPE) 17-1/2-inch hole (Figure 5A, 5B, and 5C)

Blowout prevention equipment to drill a 17-1/2-inch hole should consist of a minimum of a 21-1/4-inch - 2M annular preventer and diverter system as per Figure 5A. This configuration would be used for cases where the 20-inch shoe is set shallow in unconsolidated formation. When the shoe is set deeper in more competent formation a double-gate preventer, choke line and kill line will be added as per Figure 5B. The diverter line will be eliminated when the casing shoe is set into very competent formation at a depth which will provide control any pressure encountered, as shown in Figure 5C. The determination of which BOPE configuration to use will be dependent on the formation and casing depth and made with the approval of DLNR. Test BOPE per ...

B) Page 3 - Blowout Prevention Equipment (9-5/8-inch BOPE) 8-1/2-inch hole (Figure 7)

(Line 5) box with a valve on the side outlet (and a single-gate preventer as required by conditions), a rotating head ...

(Line 7) 24 hours prior to testing. Install blooie line and muffler. Install hydrogen sulfide ...

(Add to above paragraph) Provisions will be made to abate any well flow from the choke line or the blooie line.

DRILLING REPORTING CRITERIA

a. The Drilling Supervisor shall report to the PGV Drilling Engineer or his designated relief on the day to day operations.

b. As closely as possible, the Drilling supervisor will follow the drilling program for a particular well as provided by the Drilling Engineer. There will be changes in the drilling program as the well progresses and these changes must be discussed with the Drilling Engineer before action is taken.

c. Approximate casing setting depth will be set in the Drilling Program with assistance from the Geologist. These depths should be used absent other information. A mud program will be outlined in the Drilling Program and this program should be followed as closely as possible. The Drilling Supervisor shall have ample latitude to change the mud program as dictated by actual drilling conditions.

d. Historical drilling data have been developed regarding the PUNA GEOTHERMAL PROJECT and this data should be used to advantage in drilling wells within the project.

e. In and out mud temperatures and maximum recording temperatures will be logged on the IADC tour sheet.

f. When drilling below the 13 3/8-inch casing shoe, special precautions must be taken when encountering any lost circulation zones or drilling brakes.

g. If a drilling break is encountered when drilling, the Kelly should be picked up and bottoms up should be circulated around. The PGV Drilling Supervisor should be immediately notified along with the contractor's supervisor. A temperature survey should be run whenever a drilling break is encountered. An interpretation of the survey should be made by the Drilling Engineer before drilling further. It is important not to drill ahead with excessive temperature in the mud returns.

h. The driller should also note in the IADC Tour report of any gains or losses in mud pit volume. Any significant mud loss should be reported to the PGV and the contractors supervisors. If any continuous or significant mud volume gain is encountered, the driller should pick up the kelly and check for flow and notify the supervisors. If flow is observed, the well will be shut in immediately.

i. Based on past experience in the PUNA GEOTHERMAL PROJECT, it is imperative that constant supervision of the well be accomplished once drilling is undertaken below the 13-3/8-inch casing shoe.

j. PGV Supervisors will be in charge of all activities on location. PGV Supervisors will report to the PGV Drilling Engineer.

k. Drilling Supervisors will spend sufficient time together at the rig during change out to exchange information on the current activities. Drilling Supervisors will be on the floor, on the pump truck, in the wireline unit, etc., for all critical operations.

l. The Drilling Engineer will be responsible for engineering programs with input from the Drilling Supervisors. The Drilling Engineer will also advise and assist the Drilling Supervisors.

m. Contractor's supervisors will report to the Drilling Supervisor on location. They will also be on the floor during all crew changes.

n. Drillers and crews will work eight hour shifts. Reporting procedures for crews will be the responsibility of the drilling contractor. Drillers will log all rig operations on the IADC daily tour sheet, including the depths of all work performed. Rig crews will assist service company personnel as directed by the contractor's supervisor.

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PUNA GEOTHERMAL VENTURE

A Hawaii Partnership

November 1, 1991

Mr. William Paty
Chairman
State Department of Land and
Natural Resources
P.O. Box 621
Honolulu, Hawaii 96801

Dear Mr. Paty:

Subject: Puna Geothermal Venture Plan of Operations

On October 30, 1991, Puna Geothermal Venture (PGV) met with the Department of Land and Natural Resources (DLNR) to review the status of PGV with regard to the Geothermal Management Plan, the Plan of Operations (POO), and the future PGV needs or DLNR requirements. We believe the meeting was very productive, thanks to the DLNR staff's tough but cooperative guidance.

The attached document revises our earlier POO amendment of October 1, 1991. This document now incorporates the recommendations found in the Geothermal Management Plan and other DLNR concerns. Puna Geothermal Venture submits the attached document for your consideration and approval.

With this submittal, PGV believes it has fulfilled all necessary requirements and can now proceed with applications and/or documentation for future activities. We are now preparing the necessary documentation to submit further applications necessary to proceed with the tasks required to place the wellfield into production.

Thank you for your expeditious consideration. If I can be of further assistance, please feel free to contact me in the Hilo office at 961-2184.

Sincerely,

Maurice A. Richard
Vice President
Puna Geothermal Venture

Attachment

cc:
M. Tagamori

91165.011

101 Aupuni Street, Suite 1014-B, Hilo, Hawaii 96720 • (808) 961-2184 • Facsimile (808) 961-3531

PROPOSED MODIFICATIONS TO THE
PUNA GEOTHERMAL VENTURE
PLAN OF OPERATIONS
DECEMBER, 1988

1. INTRODUCTION

The Independent Technical Investigation of the Puna Geothermal Venture Unplanned Steam Release, June 12 and 13, 1991, Puna, Hawaii (Element I) contains recommendations for modifications and additions to the basic Puna Geothermal Venture (PGV) drilling program as described in the Geothermal Resource Permit Application Amendment for the Puna Geothermal Venture Project, December, 1988. This permit application is the Plan of Operations (POO) for PGV as approved by the Hawaii Department of Land and Natural Resources (DLNR). Puna Geothermal Venture acknowledges that it is aware that the DLNR is now the lead state regulatory agency with regard to oversight and control of both production and injection wells. Plans and modifications for the drilling of all currently permitted and any future proposed geothermal wells will be revised in accordance with these plan amendments, and will be directed to the DLNR for approval before any operations take place. In order for PGV to implement the recommendations of Element I, PGV must request and receive approval for modifications to the POO from DLNR. The purpose of this document is to describe those changes to the POO that will be implemented by PGV as recommended in Element I. The format followed in this document uses, as a reference designation, the page and paragraph of the item to be modified in the POO. The proposed changes to the POO are then described immediately following each reference.

2. PROPOSED MODIFICATIONS

2.1 Modification A

Reference:

POO: Section 3.2.1.2 Well Drilling

Add the following text at end of section:

> Appropriate drilling personnel training and supervision are vital to the safety of drilling operations in high temperature geothermal environments like that found in the PGV resource area. PGV will execute the following training and supervision policies during drilling operations:

* Puna Geothermal Venture will have two drilling supervisors assigned working an equal time schedule. The drilling contractor will provide an additional mechanic/ electrician to relieve the rig supervisors from some of the duties they have been responsible for. The contractor's rig supervisors also work an equal time schedule and do not work more than three days in a row. These changes will allow the supervisors to provide closer supervision.

  The IADC Tour Sheet will be signed daily by the three drillers on shift, the contractor's supervisor and the operator's supervisor. Copies of the tour sheets will be sent to DLNR. DLNR representatives are free to check the rig floor at any time by informing the contractor's and operator's supervisors that they are going to the floor.

* The driller will be the supervisor on the rig floor during all drilling operations. The contractor's supervisor will be on the floor during all crew changes to ensure continuity of floor supervision. During critical operations, the contractor's and/or operator's supervisor will also be on the rig floor. The driller has available direct communications with both the contractor's and the operator's supervisors. The driller will have additional supervision anytime he needs it or sees a condition that may require more attention.

* Periodic blowout prevention drills will be conducted and noted in the IADC tour reports. All personnel will receive training in BOPE operations. DLNR field personnel will be informed of the dates and times of this training and may participate in the training. Training shall consist of providing copies of the University of Texas Petroleum Extension Service, Blowout Prevention Manual. The manual will be discussed during safety meetings with the operator's supervisor. Tests will be given to all personnel to ensure that the material is understood.

* All tool pushers, drillers, and derrickmen will be trained in the use of monitoring equipment, and this training will be noted in the IADC tour reports. DLNR field personnel will be informed of the dates and times of this training and may participate in the training. Training shall consist of informal classes in the use of the Drillers Assistant Monitoring System by TECTON GEOLOGIC personnel using the Operators Manual which will be distributed. The class will cover equipment specifications and operating instructions. Tests will be

given to ensure that the material is understood. The class will be given periodically as part of pre-spud operations.

* All supervisory drilling personnel will be trained to understand the implications of changes in subsurface conditions, such as pit level changes, pump pressure changes and rate of penetration indicated by the monitoring equipment. This training will be noted in the IADC tour reports. DLNR field personnel will be informed of the dates and times of this training and may participate in the training. Training shall be included in the TECTON GEOLOGICAL Class on monitoring equipment operations. The significance of the surface changes on subsurface conditions will be discussed. The possible subsurface causes of the surface changes and their significance in the drilling operations will be pointed out.

  PGV will provide a Well Control School tailored to geothermal drilling conditions for all supervisory personnel. This school will be similar to the Well Control Course for MMS Certification and will include: (1) Pressure/Pressure Gradient; (2) Well Kicks; (3) Shut-In Procedures; (4) Circulating Out-Kicks; (5) Equipment; (6) Well Design; (7) Special Operations; (8) Common Mistakes in Well Control; and (9) Organizing and Directing Well Control.

* PGV has establish reporting criteria for subsurface conditions (attached as Appendix C) and will instruct all drilling personnel to communicate significant changes in subsurface conditions to supervisors. Examples of some of these conditions are: (1) Trip Gas/Bottoms-Up Vapor; (2) Mud Pit Level Changes; (3) Flow Line Temperature Changes; (4) Rate of Penetration Changes; (5) Pump Pressure Changes; (6) Gas Detection; (7) Mud Property Changes; (8) Formation Changes; and (9) Bottom Hole Temperature Changes. When changes in subsurface conditions will significantly affect the drilling procedure or casing program, the DLNR field representative will be informed by the operator's supervisor.

2.2 Modification B

Reference:

POO: Section 3.2.1.2 Well Drilling, Page 20, Paragraph 2

Replace Paragraph 2 with the following text:

All wells will be drilled into the geothermal resource, which may start at depths ranging from 1,600 feet to 4,000 feet below surface. Wells drilled as production wells will consist of 20-inch, 13-3/8-inch, and 9-5/8-inch diameter casings. The 20-inch casing provides hole stability and reduces the loss of drilling mud into fractures from the surface to a depth of 1,000 to 1,200 feet. The 13-3/8-inch casing will extend from the surface down to low permeability rock below the deepest Underground Source of Drinking Water (USDW). This casing string will typically be set in the 1,200 to 2,000 foot depth interval and cemented to the surface. PGV will henceforth take a conservative, flexible approach to casing the well above 2,000 feet. Drilling and casing programs will be submitted for approval on a well-by-well basis. The 9-5/8-inch casing will be set and cemented from the surface to near the top of the reservoir. The final choice of casing points for each casing string will be determined during drilling. The following mechanism is proposed whereby PGV may propose and the DLNR may approve, on-site modifications to casing programs or drilling operations.

PGV supervisors will discuss on-site modifications to casing or drilling operations with the DLNR field representative. After these discussions, the DLNR field representative will contact his supervisor and provide a detailed explanation of the proposed changes. After discussions with his supervisor, the DLNR field representative and/or his immediate supervisor shall have the authority to provide PGV with a verbal approval immediately for any modifications. PGV will submit a written sundry notice of the approved changes as soon as possible. The data used to make the casing point determinations may include but shall not be limited to the following:

* Rock stability and strength as determined by rate of penetration, sloughing, and washouts.

* Permeability as determined by rate of drilling fluid loss.

* Mineralogy indicating increased temperature, hydrothermal alteration, and mineral deposition.

* Increased formation temperature as determined by mud return temperature and periodic temperature surveys and measurement.

* Increased formation fluid pressure above normal ground water hydrostatic head as indicated by flow from the well with mud pumps shut off or increase in drilling fluid volume not accounted for by addition of drilling water.

* Influx of gases, primarily hydrogen sulfide and carbon dioxide, into the drilling fluid as determined by surface gas monitors on flow line.

* Loss of circulation below the depth of normal ground water occurrence.

* Drilling records and geotechnical data from adjacent wells.

Figure 3.3 is a diagram of a typical production well and Appendix B is a typical production well drilling and completion program. Appendix B (Revised) is a generic development well drilling program. It is acknowledged, however, that specific revised casing programs will be provided for each well, based on total knowledge accumulated on all the wells.

Replace Appendix B with the attached revised drilling program labeled Appendix B (Revised).

2.3 Modification C

Reference:

POO: Section 3.2.1.2 Well Drilling

Add the following text before first complete paragraph, page 22:

The hole drilled for the surface casing (typically a 26-inch hole for 20-inch diameter casing) is drilled without blow out prevention equipment. During the drilling of the surface hole below a depth of 500 feet, the following precautions will be taken to prevent encountering geothermal resource without the BOPE installed:

* Run maximum reading thermometers at each stand drilled looking for increases in thermal gradient.

* Take a representative water sample and have it analyzed as soon as possible to determine salinity and conductivity.

* Catch cutting samples every 10 feet and analyze them for the presence of hydrothermal alteration when we have returns to surface. We will attempt to maintain returns whenever possible.

* Monitor circulating fluid returns for abnormal increase in salinity, conductivity, or chloride content.

In the event that proximity to a geothermal zone is indicated, DLNR will be notified and operator run surface casing, cement, and install BOPE.

2.4 Modification D

Reference:

POO: Section 3.2.1.2 Well Drilling, Page 23

Add the following text at the end of Section 3.2.1.2 text, page 23:

When drilling into the production zone, a sudden release (well kick) of high pressure steam, gas, and fluid may occur. The BOPE and wellhead installed on the 13-3/8-inch casing will be designed and rated to handle such kicks, including an additional double-gate preventer in the 13-5/8-inch BOPE stack, with variable ram pipes. The BOPE will include a large diameter flow relief port which during normal drilling operations will be sealed with a low pressure burst plate. In the event of a kick, the burst plate will rupture, thereby diverting the initial high pressure pulse into a large diameter relief line. A muffler and abatement system will be installed on the relief line to minimize hydrogen sulfide emissions and noise until the flow is shut in. Details of the wellhead, BOPE and flow relief equipment are shown in Appendix B (Revised).

Control of high pressure, high temperature geothermal zones during drilling will require a high-volume drilling fluid system. The system will include a high volume water well for the continuous supply of drilling water. The mud system will be of sufficient volume to allow the mixing and storage of heavy mud required for pressure control of the well. Mud

pumps will be equipped with the maximum appropriately sized pump liners. Mud cooling capacity will be installed that is adequate to maintain mud temperatures at levels that are both safe for drilling personnel and sufficiently low to maintain proper mud properties. A larger, more efficient mud cooler will be used. The more efficient mud cooler will provide up to 50% more cooling when the mud flowline temperature is in the 125°F to 150°F range. PGV may use two coolers if PGV encounters mud temperatures that indicate the need for two coolers.

Drilling personnel and supervisors will be provided with monitors of drilling functions and conditions that provide an indication of proximity to or penetration into a geothermal production zone. The monitors will include an alarm system. The alarm levels for each function will be included in the Standard Drilling Orders. The monitoring system will include the following functions: (1) Hydrogen sulfide levels; (2) Pump pressure; (3) Rotary table torque; (4) Rate of penetration; (5) Weight on bit; and (6) Pit volume.

2.5 Modification E

Reference:

POO: Section 3.8 Geologic Report, Page 66, Paragraph 1

Add the following text at the end of Paragraph 1, page 66:

The conceptual geologic model described in Section 3.8, "Geologic Report," will change from time to time as the Project develops and new geologic data becomes available from drilling and other geoscientific studies. The geologic model revisions will be made available to DLNR in the form of confidential reports, as warranted by the proprietary data presented therein. The first confidential report will be made available to the DLNR before December 31, 1991, and shall contain a comparison and analysis of differences between PGV's earlier conceptual geologic model.

Change Page 68, line 8, the word "600°F" to "665°F".

APPENDIX B (REVISED)

PUNA GEOTHERMAL VENTURE
DEVELOPMENT WELL DRILLING PROGRAM

CONDUCTOR CASING AND CELLAR:

A thirty inch (30") conductor pipe will be set in a 42" hole that was drilled to a depth of 50' below ground level. The conductor is to be cemented in place with a Type II portland concrete cement placed down the backside of the 30" conductor pipe.

Following the setting of the conductor pipe, dig an earthen cellar and construct a reinforced concrete cellar according to civil contractor's design and specifications (Figure 2).

DRILLING - 26" HOLE:

Rig up a suitable drilling rig as shown in Figure 3. Weld on 30" pitcher nipple. Spud in with 26" bit. Anticipate losing total returns at any time below surface. Continue drilling ahead on water, aerated mud or foam without returns. Run maximum reading thermometers during directional surveys every 90' below a depth of 500'. Drill to a depth of 650'.

At this depth rig up bailer and bail continuously or as required to get a representative ground water sample. Collect samples and send to lab for analysis. Have state witness sampling procedure. Notify state 24 hours prior to taking samples.

Resume drilling 26" hole on water, aerated mud, or foam. Drill to a depth of 1000' +/-, the casing point for 20" casing. If abnormal temperatures are encountered, notify the drilling superintendant and stop drilling. The 20" casing may be set at that point after consulting with and recieving permission from Department of Land and Natural Resources (DLNR).

SURFACE CASING:

Approximately 1000' of 20" 94# K55 BT&C casing will be run and cemented in place. Run casing while filling on every second joint.

Cement 20" casing through drill pipe with type II + 40% silica flour + 2% calcium chloride + .65% CFR-3. Excess is calculated at 100%. Reciprocate casing 10' - 15' through out job.

Wait on cement for 12 hours. Have at least 200 cubic yards of sand, gravel, and/or volcanic cinders on hand.

Pick up and run 1" tubing down backside of 20" casing. Tag fill. Mix and pump type II cement + 40% silica flour + 2% calcium chloride + .65% CFR-3. Circulate to surface. Pull tubing and wash shield laying down. Wait on cement for 12 hours. Should the cement settle, top out with batched ready-mix poured down the backside of the 20" casing. Ready-mix can be accelerated with 2% by weight of calcium chloride. Wait on cement for 12 hours.

BLOWOUT PREVENTION EQUIPMENT (20-inch BOPE) 17 1/2" HOLE (Figures 5a, 5b, and 5c):

Cut off casing and weld on 20" - 2M slip on casinghead with 2 side outlets. Valve the outlets with 3" - 2M RTJ gate valves.

Blowout prevention equipment to drill a 17 1/2" hole should consist of a minimum of a 21-1/4" - 2M annular preventer and diverter system as shown in Figure 5A. This configuration would be used for cases where the 20" shoe is set shallow in unconsolidated formation. When the shoe is set deeper, in more competant formation a double-gate preventer, choke line and kill line will be added as shown in Figure 5B. The diverter line will be eliminated when the casing shoe is set into very competant formation at a depth which will provide control of any pressures encountered, as shown in Figure 5C. The determination of which BOP configuration to use will be dependant on the formation and casing depth and be made with the approval of DLNR. Test BOPE per State requirements and note test results in IADC tour report an morining report. Notify appropriate State regulatory agencies 24 hours prior to testing.

DRILLING 17 1/2" HOLE:

Drill out from underneath the 20" surface casing with mud, a 17 1/2" mill tooth bit, and slick bottomhole assembly. Drill out and trip for bottomhole assembly.

Should lost circulation persist, loss interval(s) should be cemented.

The 17 1/2" hole is to be drilled to a depth of 2000'+/- where 13 3/8" casing is to be run.

INTERMEDIATE CASING:

Approximately 2000' of 13 3/8" 61# K55 NEW VAM casing is to be run and cemented in place in a single stage.

Cement with type II cement + 40% silica flour + .65% CFR-3. If losses are encountered below the 20" casing shoe, it may be advisable to cement the 13 3/8" string with a light weight

spherlite cement slurry tailed by 200 sacks of type II slurry. Pump 60% excess.

BLOWOUT PREVENTION EQUIPMENT (13-3/8" BOPE) - 12-1/4" HOLE (Figure 6):

Cut off casing and install 13-3/8" X 13-5/8" - 5M casinghead. Blowout prevention equipment to drill a 12-1/4" hole will consist of two 13 5/8" - 5M double gate preventers, a 13 5/8" - 5M Hydril annular preventer, a banjo box with rupture disk and single gate preventor on the side outlet, a rotating drilling head, choke, and kill line. Test BOPE as per State requirements and note test results in IADC tour report and morning report. Notify appropriate state regulatory agencies 24 hours prior to testing. (See Figure 6). Install blooie line and muffler. Install hydrogen sulfide abatement equipment on blooie line (Figure 10).

DRILLING 12 1/4" HOLE:

Drill out the shoe with a 12 1/4" bit and slick bottomhole assembly. Conduct leak-off test by pressuring well to the equivalent to 11#/gal fluid. Squeeze if required. Trip for bottomhole assembly. Drill to casing point at 3900'+/-.

PRODUCTION CASING:

Approximately 3900' of 9 5/8" 47# C90 NEW VAM casing is to be run and cemented. Cement casing type II cement + 40% silica flour + 50 lb/sk of spherulite + 4% gel + 1.25% CFR-3 + 1.5% HALAD 22A. Excess is calculated at 60%. After WOC, cut off the 9 5/8" casing. Dress casing 8" above casinghead flange with 27 1/2° chamfer. Nipple up 13 5/8" - 5M x 10" - 5M Type S WKM Expansion Spool with packing sleeve.

BLOWOUT PREVENTION EQUIPMENT (9-5/8" BOPE) - 8-1/2" HOLE (Figure 7):

Blowout prevention equipment to drill the 8 1/2" section of hole should consist of a 10" - 5M WKM gate valve, 10" - 5M x 13-5/8" - 5M DSA, two 13 5/8" - 5M double gate preventers, a 13 5/8" - 5M Hydril annular preventer, a banjo box with a valve on the side outlet (and a single-gate preventor as required by conditions), a rotating drilling head, choke, and kill line. Test BOPE as per State requirements and note test results in IADC tour report and morning report. Notify appropriate state regulatory agencies 24 hours prior to testing. Install blooie line and muffler. Install hydrogen sulfide abatement equipment and muffler on choke line. Provisions will be made to abate any well flow from the choke line or the blooie line.

DRILLING 8 1/2" HOLE:

Drill out from underneath the 9 5/8" casing on water with an 8 1/2" bit and slick bottomhole assembly. Perform leakoff test and squeeze if required. Trip for packed BHA and continue drilling ahead on mud.

Should differential sticking occur, rig up the air compressor with the degasser to free the stuck string.

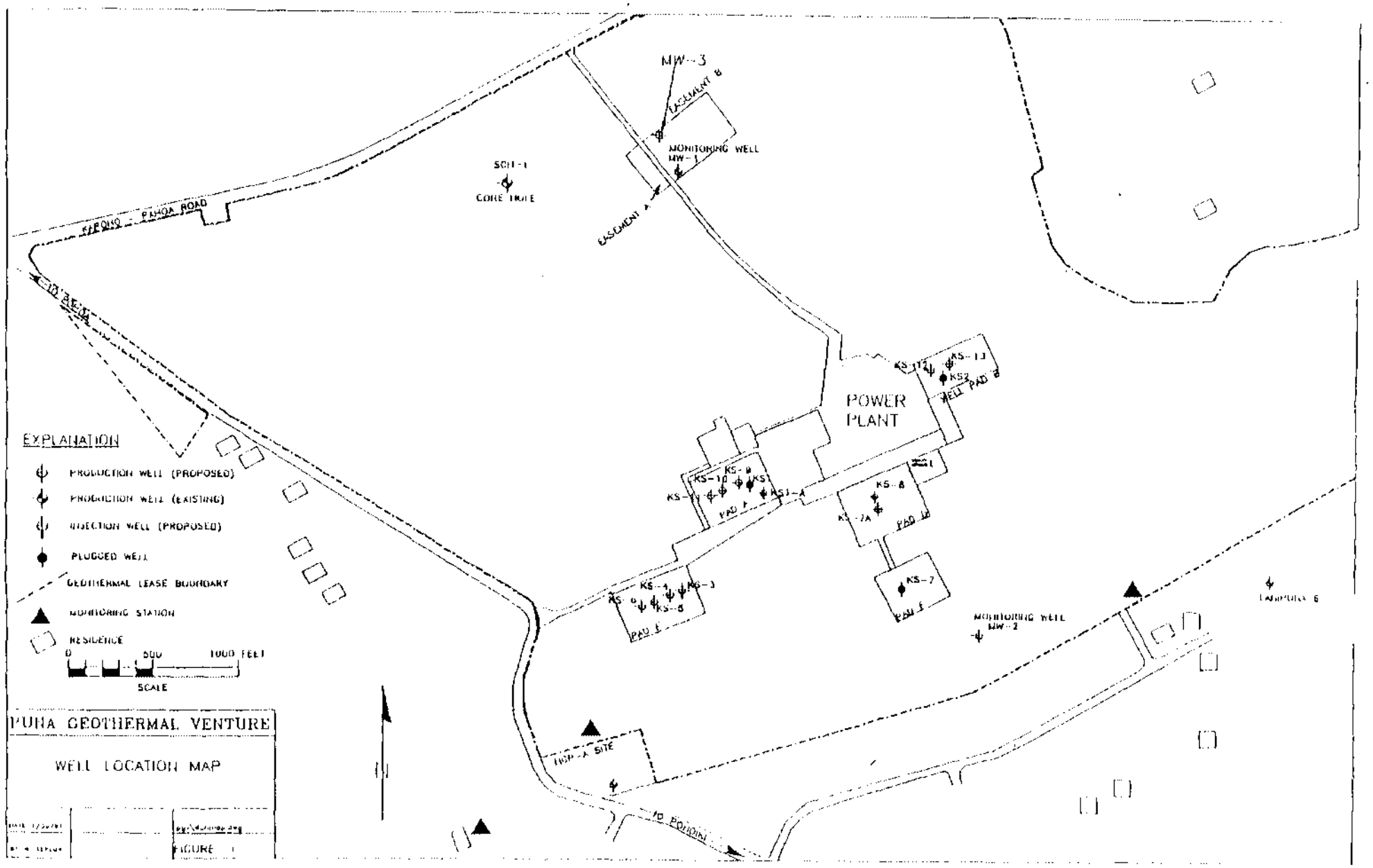
At 7400' +/- TVD circulate out mud with fresh water. Trip-out of hole and rig up flow test. If test is successful, run production liner if required.

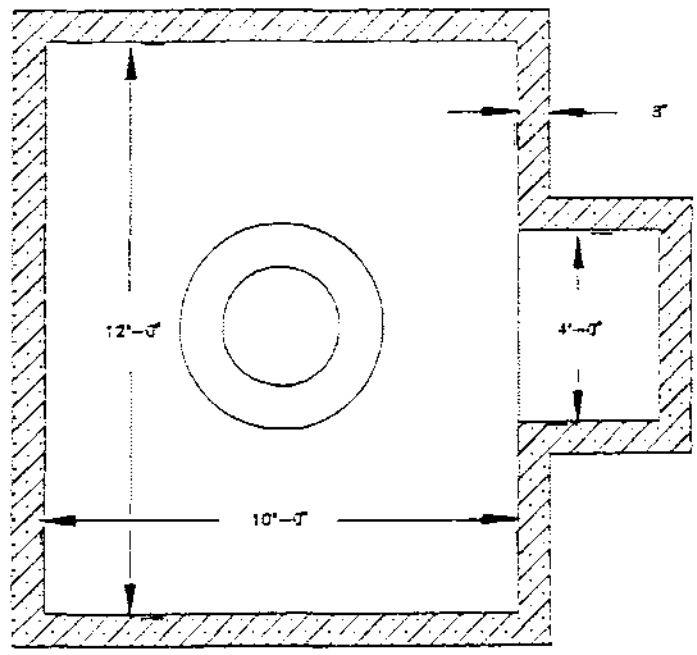
PRODUCTION LINER:

Trip in hole with slick BHA and check for fill. If hole is opened, run approximately 3800' of 7" 29# L80 BT&C casing slotted with 1/4" x 2" slots on 12 row pattern. Run liner with cement guide shoe on bottom and hang on 7" x 9 5/8" single slip cone type liner hanger. Release from hanger and trip out laying down.

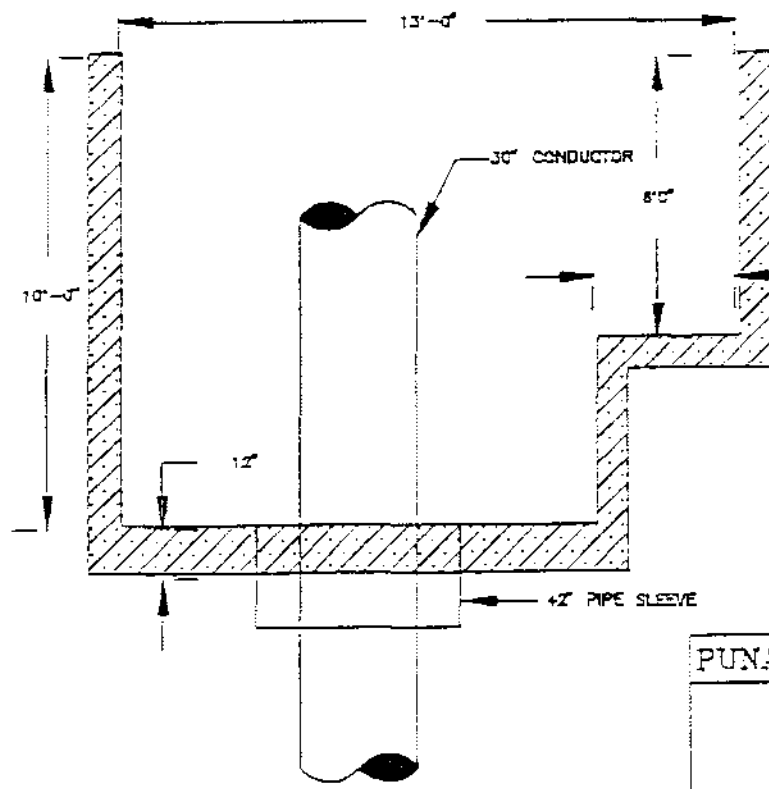
Nipple down BOP and install final wellhead for production well as show in Figure 8.

If well is to be used for injection, an optional 7" injection liner may be installed. Run approximately 3700' of 7" 29# SM-22 New Vam casing and hang on donut type hanger set in top of 10" X 13-5/8" expansion spool (Figure 9).


MW-3
EASEMENT B
MONITORING WELL
MW-1
SCH-1
CORE HOLE
EASEMENT A
POWER
PLANT
KS-12
KS-13
KS-11
KS-9
KS-10
KS-8
KS-7
KS-1
KS-2
KS-3
KS-4
KS-5
KS-6
MONITORING WELL
MW-2
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
PLUGGED WELL
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
FIGURE 1



PLAN



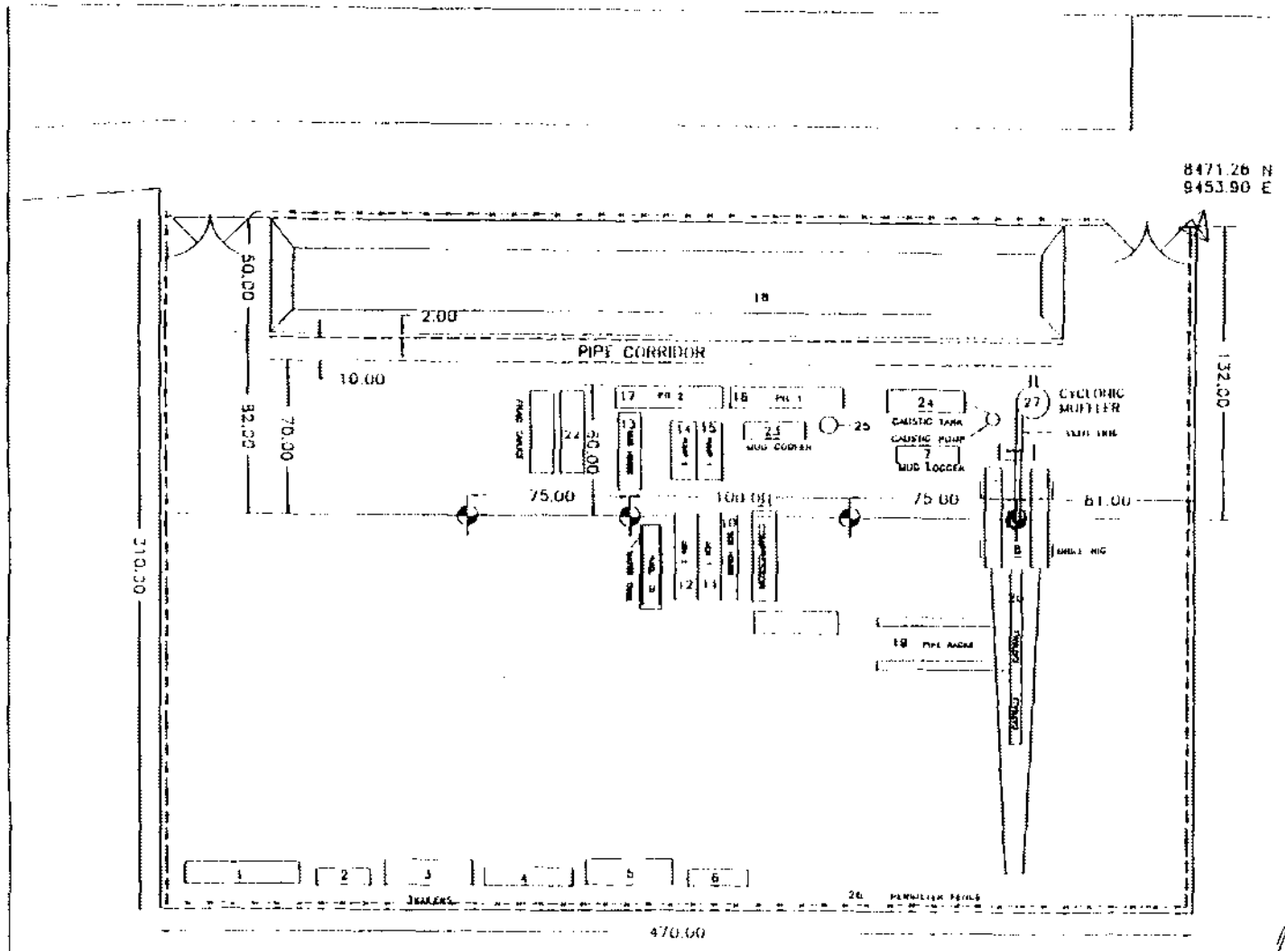
VERTICAL SECTION

PUNA GEOTHERMAL VENTURE

PRODUCTION WELL
CELLAR

DATE 3/12/90 | SCALE 1" = 4' | file: pgv\cellar.dwg

BY W. TAYLOR | FIGURE NO. 2



EQUIPMENT LIST

ITEM	HEIGHT (FT)
1. GEOLOGIST TRAILER	14.0
2. DIRECTIONAL SERVICES	12.0
3. AIR SERVICES	12.0
4. TOOL PUSHER	12.0
5. DRILLING SUPERINTENDENT	14.0
6. MUD SERVICES	12.0
7. MUD LOGGER	12.0
8. DRILL RIG	168.0
9. WATER TANK\FUEL TANK	20.0
10. SCR HOUSE	10.5
11. GENERATOR #1	10.7
12. GENERATOR #2	10.7
13. MUD HOUSE	9.4
14. MUD PUMP #1	10.5
15. MUD PUMP #2	10.5
16. MUD TANK #1	4.4
17. MUD TANK #2	4.4
18. RESERVE PIT	-10.0
19. PIPE RACKS (2)	6.7
20. CATWALK	4.4
21. AIR COMPRESSOR	20.0
22. FRAC TANKS (4)	14.0
23. MUD COOLER	24.1
24. CAUSTIC TANK	14.0
25. DEGASSER	20.0
26. PERIMETER FENCE	7.0
27. CYCLONIC MUFFLER	15.0

0 30 100 FEET
SCALE

N

PUNA GEOTHERMAL VENTURE

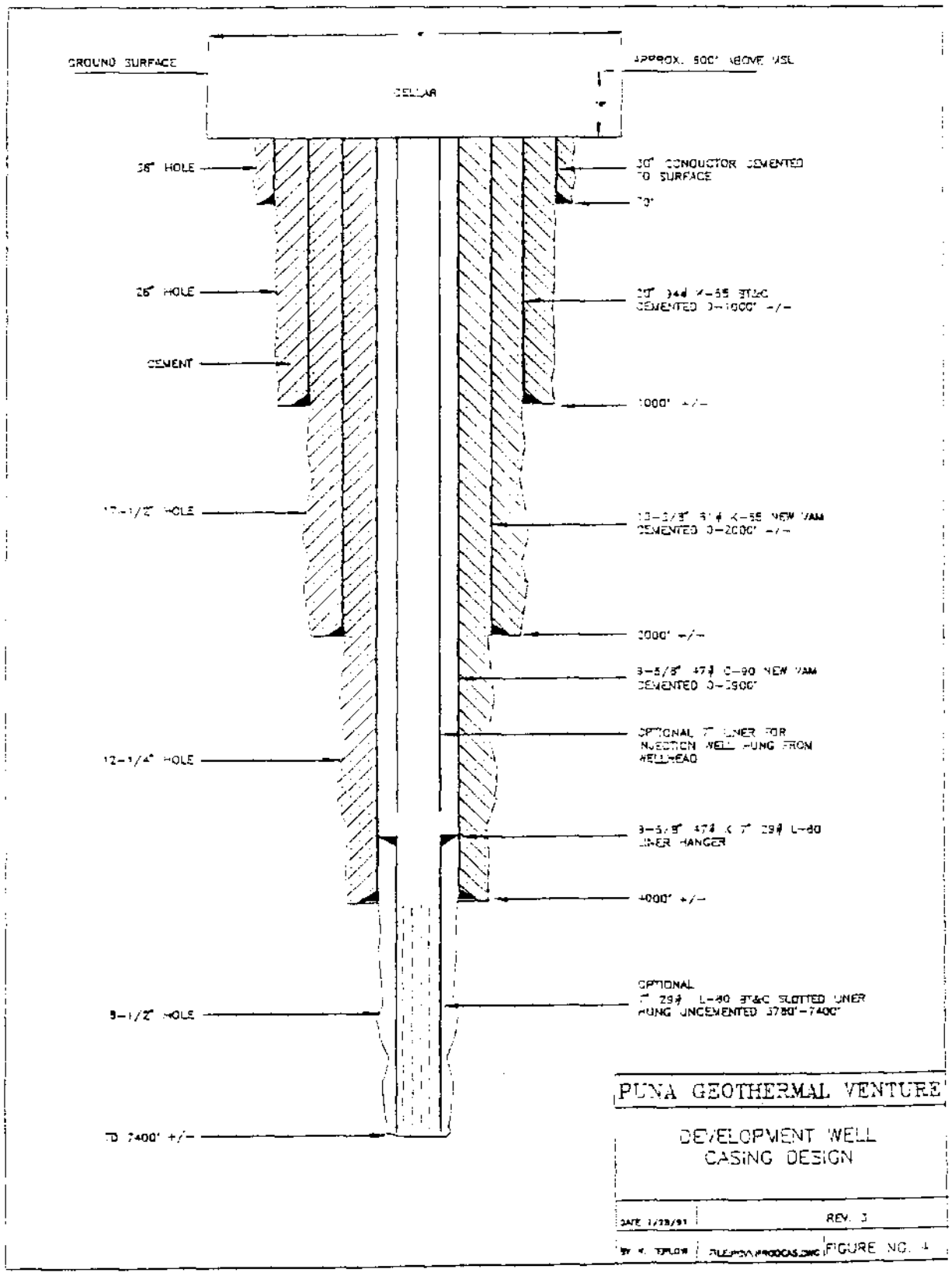
TYPICAL DEVELOPMENT WELL RIG LAYOUT

REV. 6/21/91

NEW TAYLOR

FILE POSITIVE

FIGURE NO. 5

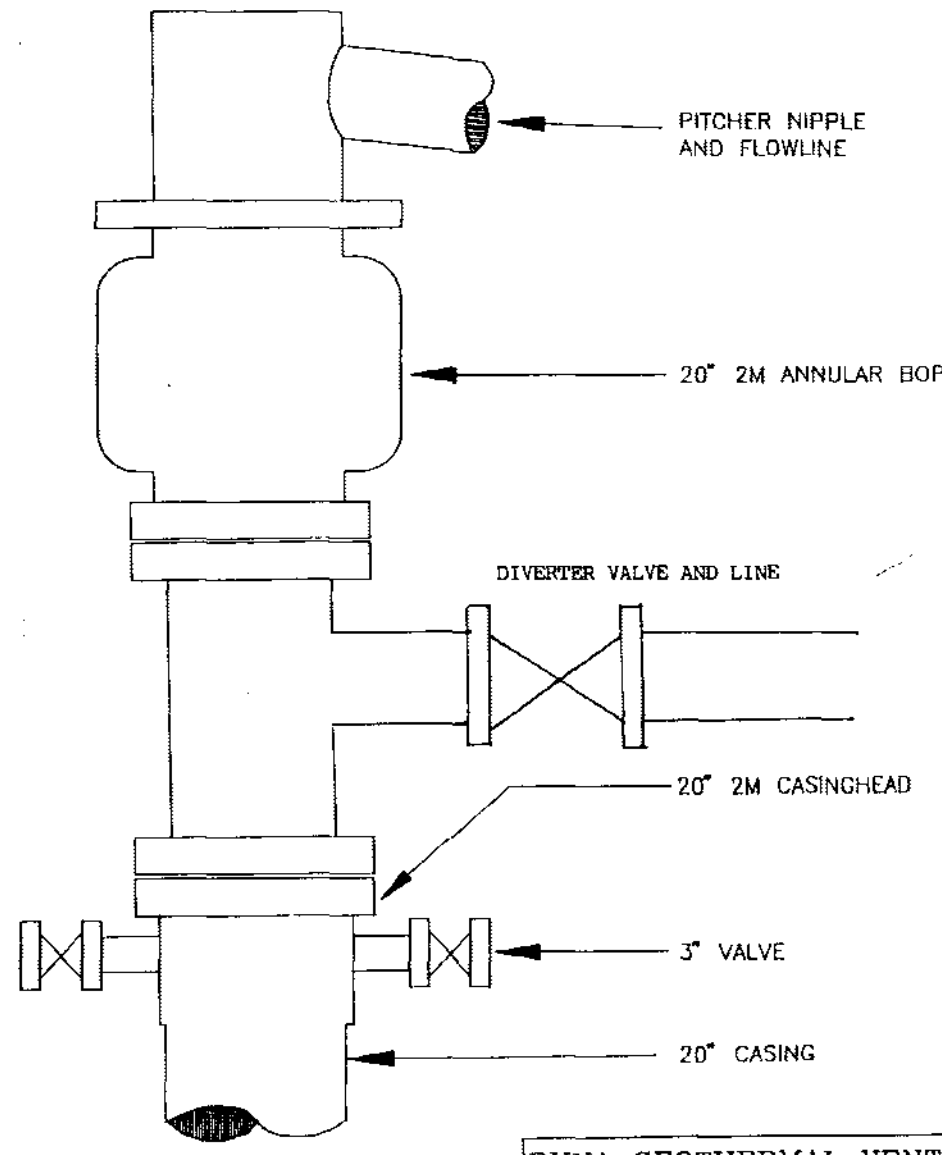


PUNA GEOTHERMAL VENTURE

DEVELOPMENT WELL
CASING DESIGN

DATE 1/28/91	REV. 3
BY K. TAYLOR	FILE PGV-WDCAS.DWG

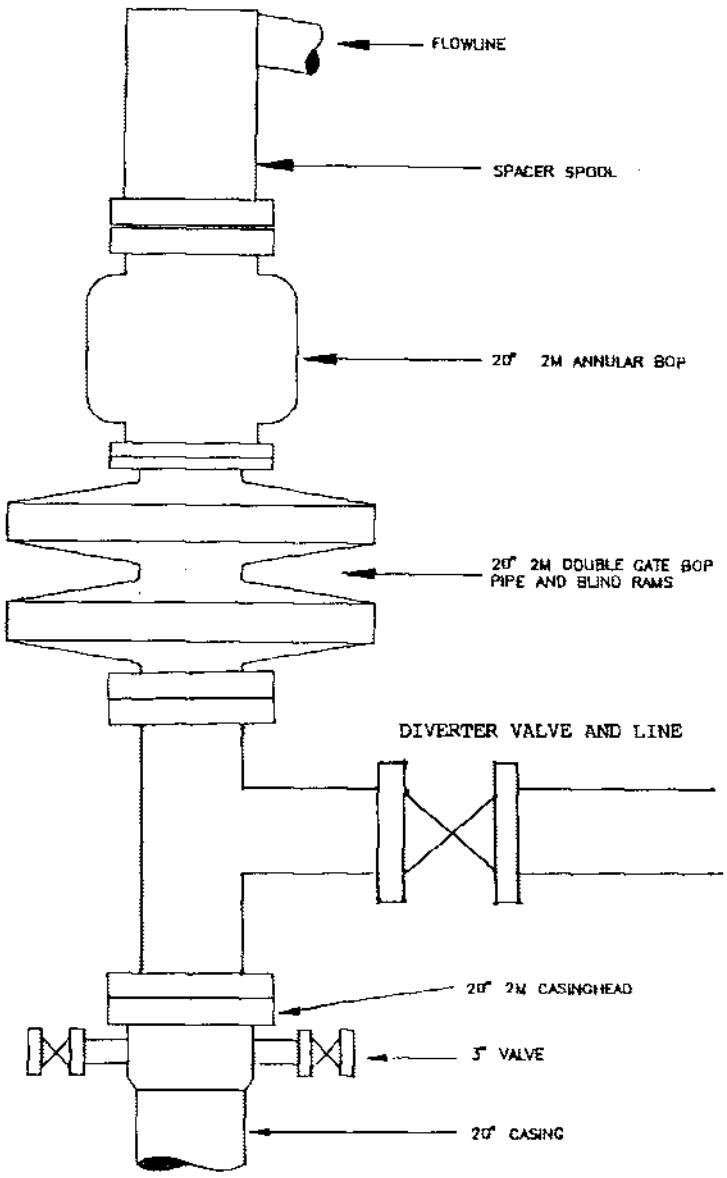
FIGURE NO. 4



PUNA GEOTHERMAL VENTURE

20" BOP
CONFIGURATION

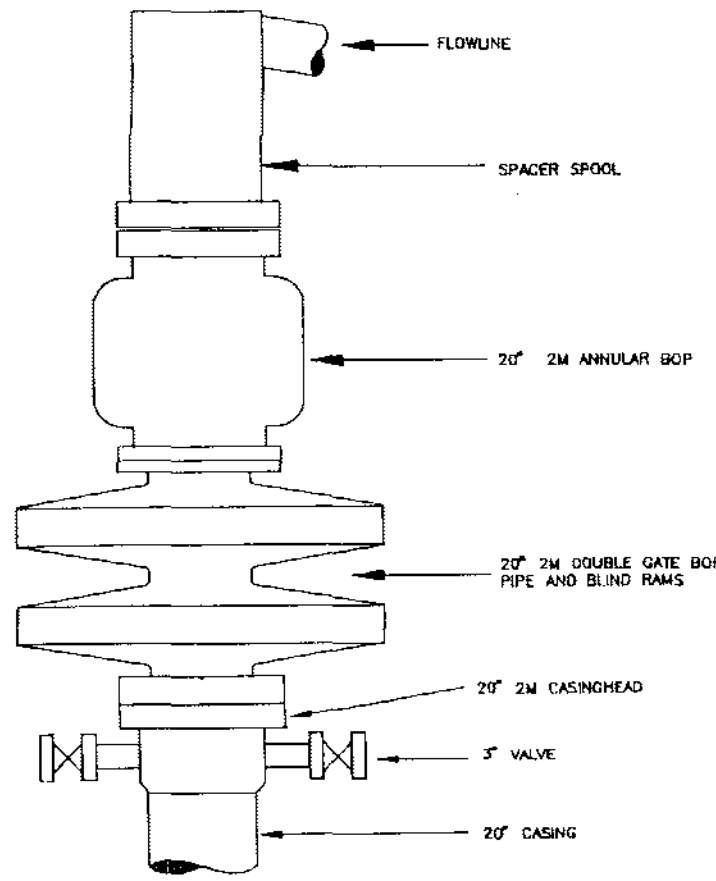
DATE 10/1/91		REV. 2
BY W. TEPLOW		FIGURE NO. 5



PUNA GEOTHERMAL VENTURE

20" BOP
CONFIGURATION
FOR PGV DEVELOPMENT WELLS

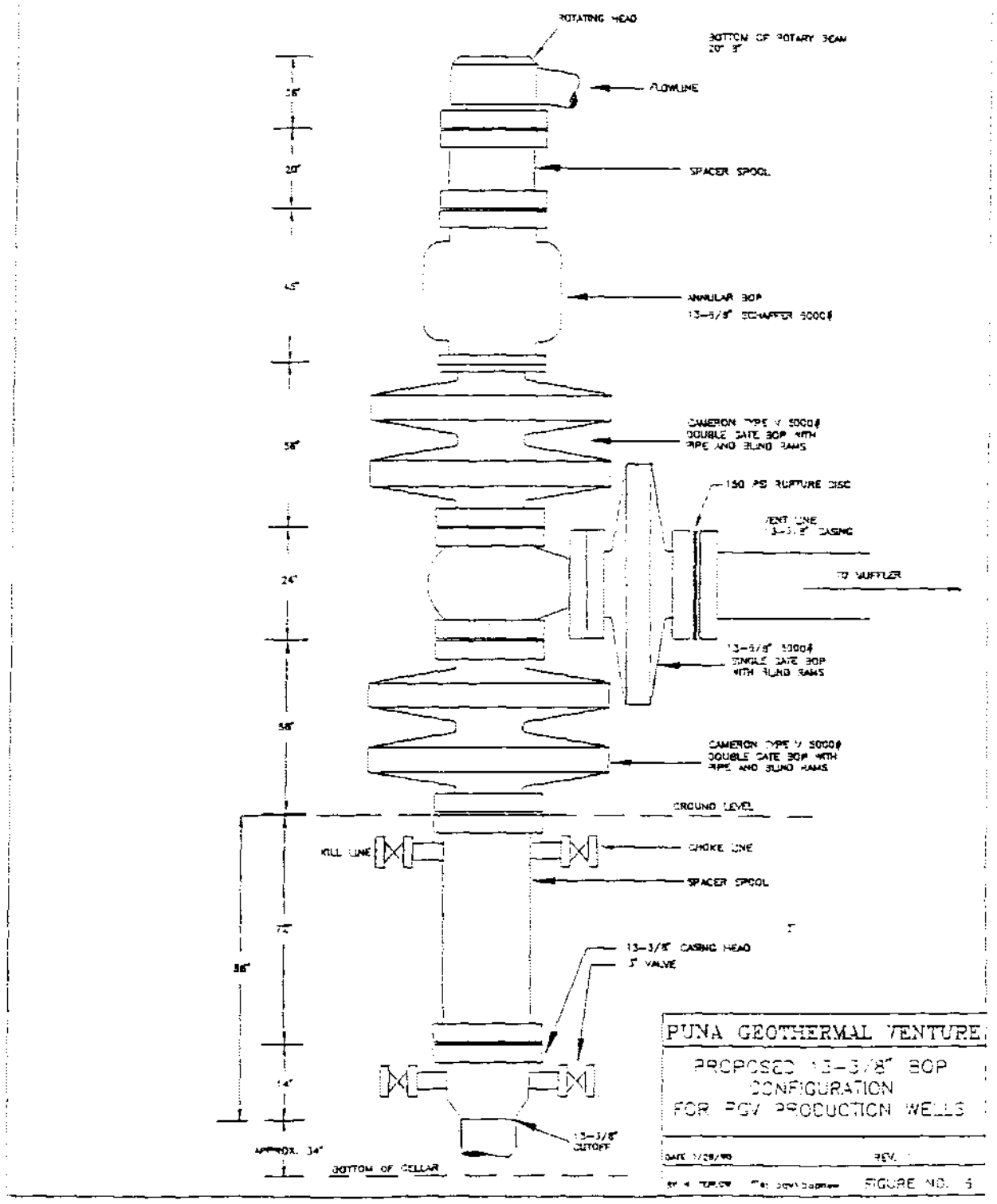
DATE 3/26/90		REV. 1
BY M. TEPLOW	file: pgv\bop20new	FIGURE NO. 5B

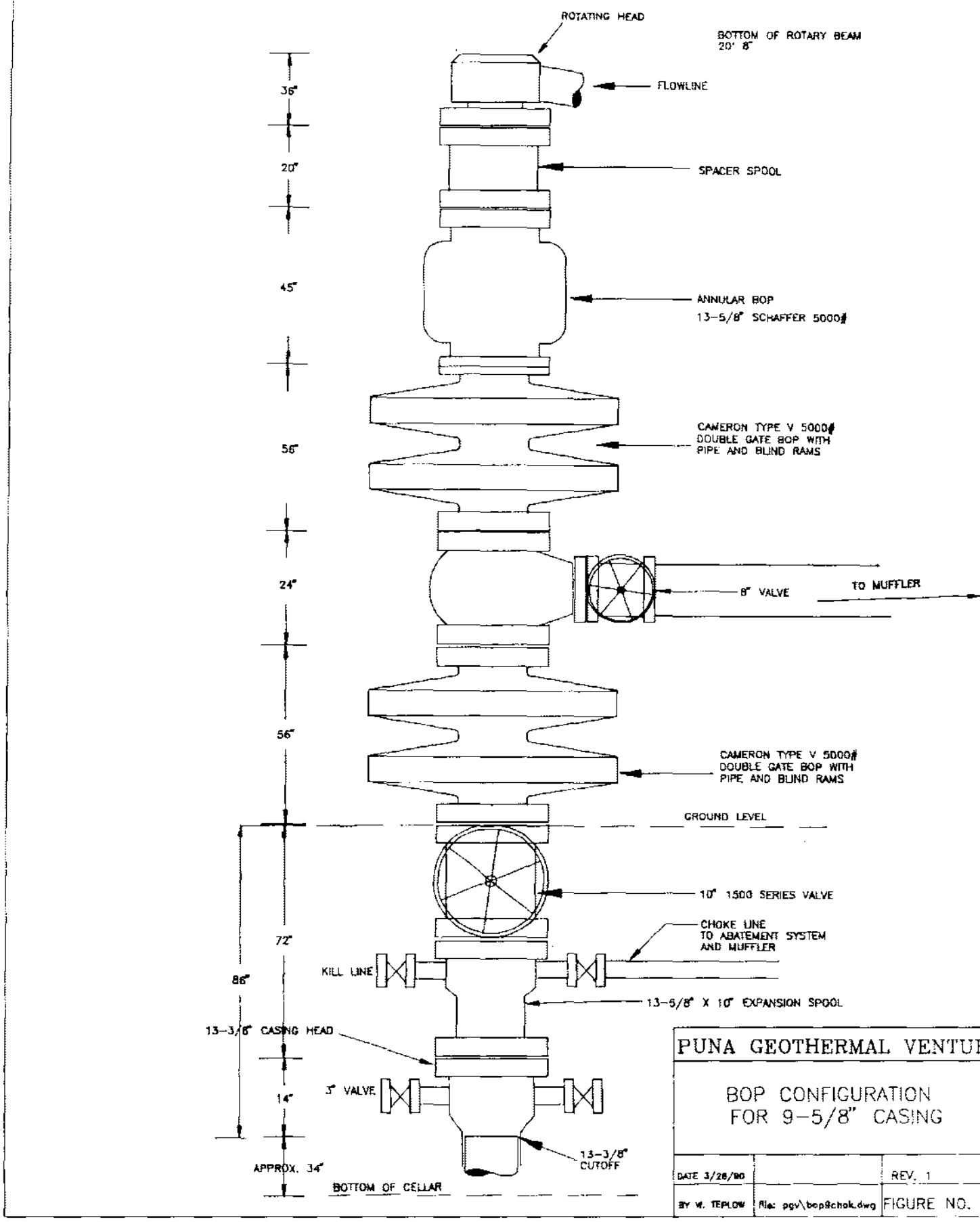


PUNA GEOTHERMAL VENTURE

20" BOP
CONFIGURATION
FOR PGV DEVELOPMENT WELLS

DATE 3/26/90		REV. 1
BY W. TEPLOW	file: pgv\bop20new	FIGURE NO. 5C

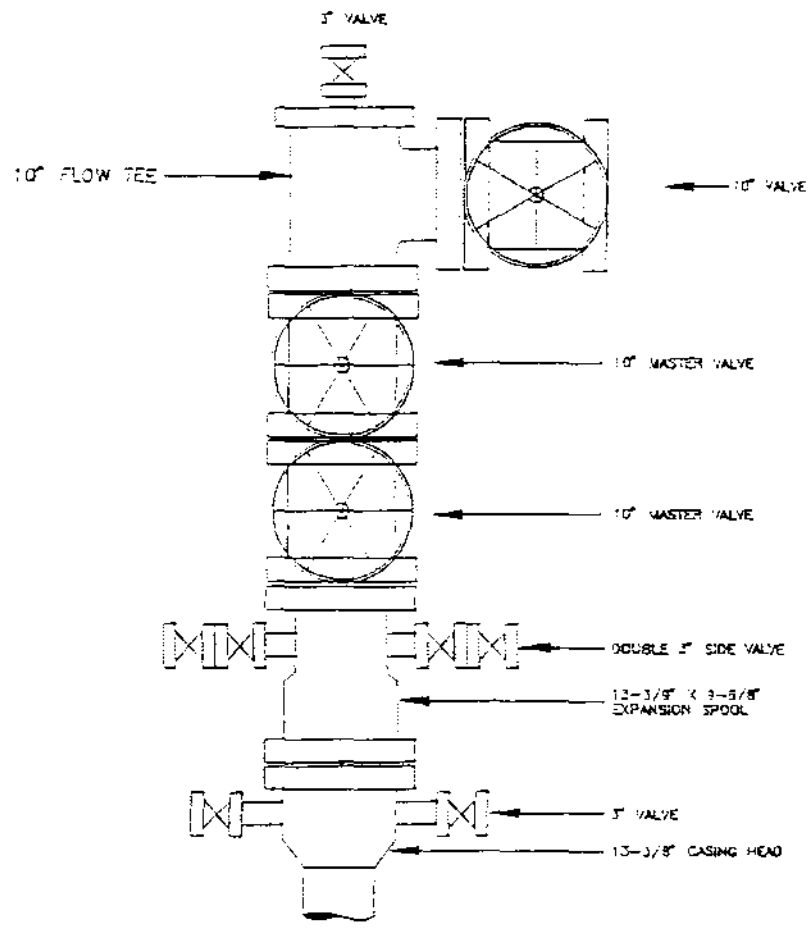

ROTATING HEAD
BOTTOM OF ROTARY BEAM
20' 9"
FLOWLINE
SPACER SPOOL
ANNULAR BOP
13-5/8" SCHAFFER 5000#
CAMERON TYPE U 5000#
DOUBLE GATE BOP WITH
PIPE AND BLIND RAMS
150 PSI RUPTURE DISC
TO MUFFLER
13-5/8" 5000#
SINGLE GATE BOP
WITH BLIND RAMS
CAMERON TYPE U 5000#
DOUBLE GATE BOP WITH
PIPE AND BLIND RAMS
GROUND LEVEL
KILL LINE
CHOKE LINE
SPACER SPOOL
13-3/8" CASING HEAD
3" VALVE
13-3/8"
CUTOFF
BOTTOM OF CELLAR
PUNA GEOTHERMAL VENTURE
PROPOSED 13-3/8" BOP
CONFIGURATION
FOR PGV PRODUCTION WELLS
REV.
FIGURE NO. 6



PUNA GEOTHERMAL VENTURE

BOP CONFIGURATION
FOR 9-5/8" CASING

DATE 3/28/90		REV. 1
BY W. TEPLOW	file: pgv\bop8chok.dwg	FIGURE NO. 7

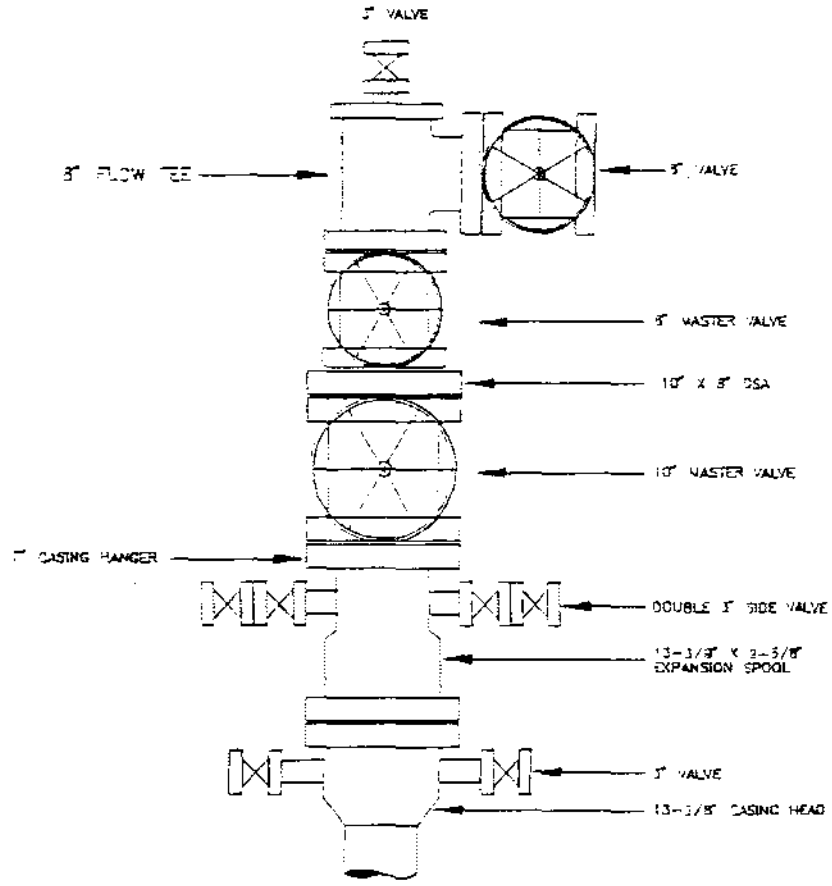


PUNA GEOTHERMAL VENTURE

PRODUCTION WELLHEAD
CONFIGURATION

DATE 3/28/90 REV. 1

BY K. TEPLOW FIGURE NO. 3

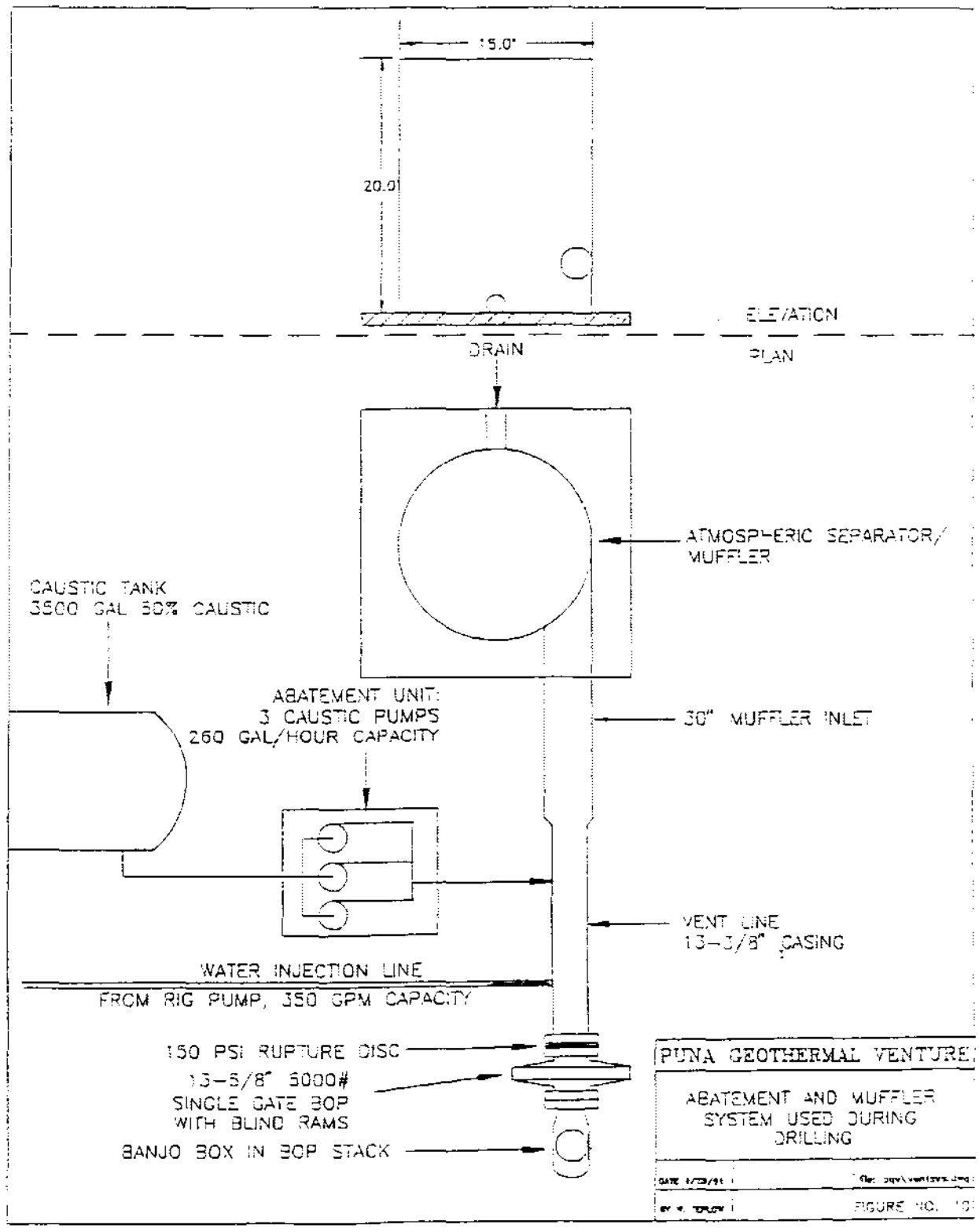


PUNA GEOTHERMAL VENTURE

INJECTION WELLHEAD CONFIGURATION

DATE 5/28/97 | File: jgs\injection.dwg | REV. 1

BY = TDFLOW | FIGURE NO. 3


15.0'
20.0'
ELEVATION
PLAN
DRAIN
ATMOSPHERIC SEPARATOR/
MUFFLER
CAUSTIC TANK
3500 GAL 50% CAUSTIC
3 CAUSTIC PUMPS
260 GAL/HOUR CAPACITY
ABATEMENT UNIT:
30" MUFFLER INLET
VENT LINE
13-3/8" CASING
WATER INJECTION LINE
FROM RIG PUMP, 350 GPM CAPACITY
150 PSI RUPTURE DISC
13-5/8" 5000#
SINGLE GATE BOP
WITH BLIND RAMS
BANJO BOX IN BOP STACK
PUNA GEOTHERMAL VENTURE
ABATEMENT AND MUFFLER
SYSTEM USED DURING
DRILLING
FIGURE NO.

APPENDIX C
DRILLING REPORTING CRITERIA

a. The Drilling Supervisor shall report to the PGV Drilling Engineer or his designated relief on the day to day operations.

b. As closely as possible, the Drilling supervisor will follow the drilling program for a particular well as provided by the Drilling Engineer. There will be changes in the drilling program as the well progresses and these changes must be discussed with the Drilling Engineer before action is taken.

c. Approximate casing setting depth will be set in the Drilling Program with assistance from the Geologist. These depths should be used absent other information. A mud program will be outlined in the Drilling Program and this program should be followed as closely as possible. The Drilling Supervisor shall have ample latitude to change the mud program as dictated by actual drilling conditions.

d. Historical drilling data have been developed regarding the PUNA GEOTHERMAL PROJECT and this data should be used to advantage in drilling wells within the project.

e. In and out mud temperatures and maximum recording temperatures will be logged on the IADC tour sheet.

f. When drilling below the 13 3/8-inch casing shoe, special precautions must be taken when encountering any lost circulation zones or drilling brakes.

g. If a drilling break is encountered when drilling, the Kelly should be picked up and bottoms up should be circulated around. The PGV Drilling Supervisor should be immediately notified along with the contractor's supervisor. A temperature survey should be run whenever a drilling break is encountered. An interpretation of the survey should be made by the Drilling Engineer before drilling further. It is important not to drill ahead with excessive temperature in the mud returns.

h. The driller should also note in the IADC Tour report of any gains or losses in mud pit volume. Any significant mud loss should be reported to the PGV and the contractors supervisors. If any continuous or significant mud volume gain is encountered, the driller should pick up the kelly and check for flow and notify the supervisors. If flow is observed, the well will be shut in immediately.

i. Based on past experience in the PUNA GEOTHERMAL PROJECT, it is imperative that constant supervision of the well be accomplished once drilling is undertaken below the 13-3/8-inch casing shoe.

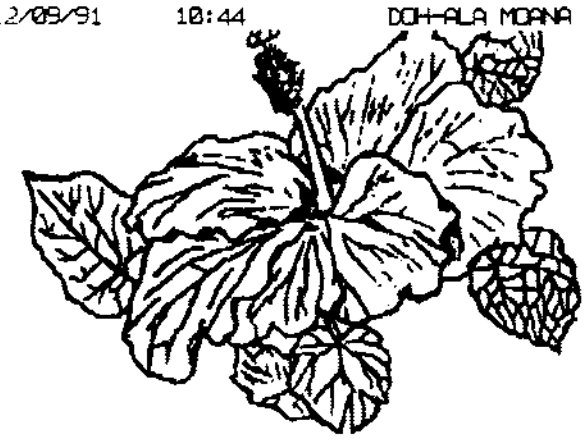
j. PGV Supervisors will be in charge of all activities on location. PGV Supervisors will report to the PGV Drilling Engineer.

k. Drilling Supervisors will spend sufficient time together at the rig during change out to exchange information on the current activities. Drilling Supervisors will be on the floor, on the pump truck, in the wireline unit, etc., for all critical operations.

l. The Drilling Engineer will be responsible for engineering programs with input from the Drilling Supervisors. The Drilling Engineer will also advise and assist the Drilling Supervisors.

m. Contractor's supervisors will report to the Drilling Supervisor on location. They will also be on the floor during all crew changes.

n. Drillers and crews will work eight hour shifts. Reporting procedures for crews will be the responsibility of the drilling contractor. Drillers will log all rig operations on the IADC daily tour sheet, including the depths of all work performed. Rig crews will assist service company personnel as directed by the contractor's supervisor.



FACSIMILE TRANSMISSION REQUEST
Hawaii State Department of Health, Ala Moana Health Center
FAX No. (808) 586-4729

ADDRESSEE: (NAME/ORGANIZATION AND PHONE NO.)	FROM: (NAME/ORGANIZATION AND PHONE NO.)
JANET SWIFT DEPT OF LAND & NATURAL RESOURCES 587-0219	DEPARTMENT OF HEALTH ALA MOANA HEALTH CENTER Jerry Haruno Noise and Radiation Branch 548-4383
TOTAL PAGES (Including cover page): 3	DATE: December 9, 1991

REMARKS:

Attached is the Noise Addendum for inclusion in the Plan of Operation. Following discussions with Maurice Richard, we have reached agreement on all items specified in the Noise Control Program.

Copy has been faxed to PGV.

IF RETRANSMISSION IS NECESSARY, PLEASE CALL _____ AT (808) _____. THANK YOU.

NOISE CONTROL PROGRAM
PUNA GEOTHERMAL VENTURE

A. ALLOWABLE NOISE LEVELS

1. Drilling and Well Testing operations

55 dBA	Daytime (7:00 a.m. to 7:00 p.m.)
45 dBA	Nighttime (7:00 p.m. to 7:00 a.m.)

1.1. Allowable noise levels shall apply to any point along the boundary of Puna Geothermal Venture project site.

2. Drilling and Well Testing Operations (Well Pad "E" ONLY)

55 dBA	Daytime (7:00 a.m. to 7:00 p.m.)
47 dBA	Nighttime (7:00 p.m. to 7:00 a.m.)

2.1. Allowable noise levels shall apply to any residential property boundary (exterior) which may be impacted by the noise from the operations.

3. Power plant and steam field operations

53 dBA	Daytime (7:00 a.m. to 7:00 p.m.)
44 dBA	Nighttime (7:00 p.m. to 7:00 a.m.)

3.1. Allowable noise levels shall apply to any point along the boundary of Puna Geothermal Venture project site.

4. Construction Operations and General Activities

55 dBA	Daytime (7:00 a.m. to 7:00 p.m.)
45 dBA	Nighttime (7:00 p.m. to 7:00 a.m.)

4.1. Allowable noise levels shall apply at any point along the boundary of Puna Geothermal Venture project site.

5. Noise levels shall not exceed the allowable noise levels for more than ten per cent of the time within any twenty-minute period.

6. The allowable noise levels shall be waived in cases of emergencies. An emergency is defined as an accident, imminent loss of equipment or unforeseen event requiring immediate action to protect public health, safety or welfare. All such emergencies shall be reported to the Noise and Radiation Branch as soon as possible.

7. If sound measurements indicate levels exceeding the allowable noise levels specified above, the activity creating the excessive noise levels shall be terminated OR immediate mitigative measures implemented.

B. Conditions

1. Impact type noise shall be restricted to daytime hours (7:00 a.m. to 7:00 p.m.) whenever possible and safe. Impact noise means any sound with a rapid rise and decay of sound pressure level, lasting less than one second, caused by sudden contact between two or more surfaces, or caused by a sudden release of pressure.

2. Puna Geothermal Venture shall design project components generally consistent with the best available control technology (BACT) noise abatement measures.

3. Mitigation plans shall be submitted to the Noise and Radiation Branch prior to commencement of each phase of operation, in order to minimize noise emissions and insure compliance with the allowable noise levels. The Noise and Radiation Branch shall determine and insure BACT for each operational phase consistent with available technical resource information and recommendation.

4. The Noise and Radiation Branch or authorized representative shall have jurisdiction over noise investigations, enforcement procedures and noise monitoring.

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCIII

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

GEOTHERMAL WELL MODIFICATION PERMIT

Kapoho State No. 8 (KS-8)
Kapoho, Puna, Hawaii

TO: Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Your application dated February 3, 1992, for a permit to modify and complete geothermal injection well KS-8 as a production well located within the Kapoho Section of the Kilauea Lower East Rift Geothermal Resource Subzone and covered under the State of Hawaii, Geothermal Resource Mining Lease No. R-2 is approved.

Well Designation: Kapoho State No. 8 (KS-8)
Location: TMK 1-4-01:19, Kapoho, Puna, Hawaii (Well Pad D)
Leased to: Kapoho Land Partnership
Subleased to: Puna Geothermal Venture
Operator: AMOR VIII Corporation
Ground Elevation: 629 +/- ft.
Total Depth: 3,800 feet

You are hereby granted permission to modify the geothermal well described above and in your application. Modification of the well shall be completed in accordance with the approved modification plans and in accordance with the Department's Administrative Rules, Chapter 13-183, HAR, and under the following conditions:

(1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Drilling and Completion Program submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;

(2) The permittee, its successors and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit;

(3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;

(4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;

(5) The permittee shall notify the Division of Water Resource Management (DWRM), in writing, of the date of the start of the well modification/completion work;

(6) The permittee shall submit to the Department the bottom-hole target location and direction of any proposed deviation;

(7) All blow-out prevention equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operations on the well. Test pressures shall not be less than 600 pounds per square inch nor greater than 1,500 pounds per square inch, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department.

If a drop of more than ten percent of the casing test pressure is recorded, the operator shall then run a caliper log and/or other appropriate well test to determine if the casing is defective and if corrective measures will be required before commencing any further operations. The results of the prescribed casing tests and any remedial work conducted shall be submitted to the Department within sixty days after completion;

(8) Class "G" cement shall be used in any casing cementing operations and shall contain a high temperature resistant admix;

(9) If changes to the proposed well completion program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;

(10) Approval by the Department of Health must be received prior to commencement of injection operations proposed within the KS-8 Well Test Program;

(11) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;

(12) The permittee shall submit to the Chairperson, the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor within six months after completion of the well;

(13) A well completion report, an as-built drawing of the well, and the location of the well plotted on an U.S.G.S. quad scale map shall be filed with the Department within six months after completion of the well modification;

(14) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original condition; and

(15) This permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Department of Land and Natural Resources

FEB 13 1992
Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

GEOTHERMAL WELL CONVERSION PERMIT

Kapoho State No. 1-A (KS-1A)
Kapoho, Puna, Hawaii

TO: Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Your application dated December 9, 1991, for a permit to convert geothermal production well Kapoho State No. 1-A to an injection well is approved:

Well Designation: Kapoho State No. 1-A (KS-1A)
Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii (Well Pad A)
Leased to: Kapoho Land Partnership
Subleased to: Puna Geothermal Venture
Operator: AMOR VIII Corporation
Ground Elevation: 620 +/- ft.
Total Depth: 6,505 feet

You are hereby granted permission to convert geothermal well KS-1A to an injection well. Conversion of KS-1A from a production well to an injection well is contingent upon successful completion of a Testing and Injection Program as specified in the Underground Injection Permit No. 1529 and the following conditions:

(1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Drilling and Completion Program submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;

(2) The permittee, its successors and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for

property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit;

(3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;

(4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;

(5) The permittee shall notify the Division of Water Resource Management (DWRM), in writing, of the date of the start of the well modification/completion work;

(6) All blow-out prevention equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operations on the well. Test pressures shall not be less than 600 pounds per square inch nor greater than 1,500 pounds per square inch, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department.

If a drop of more than ten percent of the casing test pressure is recorded, the operator shall then run a caliper log and/or other appropriate well test to determine if the casing is defective and if corrective measures will be required before commencing any further operations. The results of the prescribed casing tests and any remedial work conducted shall be submitted to the Department within sixty days after completion;

(7) Class "G" cement shall be used in any casing cementing operations and shall contain a high temperature resistant admix;

(8) If changes to the proposed well completion program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;

(9) Approval by the Department of Health must be received prior to commencement of injection operations proposed within the KS-1A Testing and Injection Program;

(10) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;

(11) The permittee shall submit to the Chairperson, the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor within six months after completion of the well;

(12) A well completion report, an as-built drawing of the well, and the location of the well plotted on an U.S.G.S. quad scale map shall be filed with the Department within six months after completion of the well conversion;

(13) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original condition; and

(14) This permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Department of Land and Natural Resources

FEB 13 1992

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

JOHN WAIHEE
GOVERNOR OF HAWAII

MAR 4 1992

WILLIAM W. PATY, CHAIRPERSON
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STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

GEOTHERMAL WELL MODIFICATION AND CONVERSION PERMIT
Kapoho State No. 3 (KS-3)
Kapoho, Puna, Hawaii

TO: Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Your application dated December 9, 1991, for a permit to modify and convert geothermal production well Kapoho State No. 3 (KS-3) to an injection well, located within the Kapoho Section of the Kilauea Lower East Rift Geothermal Resource Subzone and covered under the State of Hawaii, Geothermal Resource Mining Lease No. R-2, is approved:

Well Designation: Kapoho State No. 3 (KS-3)
Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii (Well Pad E)
Leased to: Kapoho Land Partnership
Subleased to: Puna Geothermal Venture
Operator: AMOR VIII Corporation
Ground Elevation: 620 +/- feet
Total Depth: 7,316 feet

Puna Geothermal Venture is hereby granted permission to modify and convert geothermal production well KS-3 to an injection well.

Modification of well KS-3 shall be completed in accordance with the approved modification plans (KS-3 Recompletion Program) and in accordance with the Department's (Department of Land and Natural Resources) Administrative Rules, Chapter 13-183, HAR, and conditions 1 through 15 of this permit.

Conversion of well KS-3 from a production well to an injection well shall be contingent upon successful completion of a Testing and Injection Program approved by the Department of Health and as specified in the Underground Injection Permit No. 1529 and the following conditions:

(1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Program for Recompletion, and the Program for Testing and Injection submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;

(2) The permittee, its successors, and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim, or demand for property damage, personal injury, and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors, and agents under this permit or relating to or connected with the granting of this permit;

(3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;

(4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;

(5) The permittee shall notify the Division of Water Resource Management (DWRM), in writing, of the date of the start of the well modification/completion work;

(6) The permittee shall submit to the Department the bottom-hole target location and direction of any proposed deviation;

(7) All Blow-Out Prevention Equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operations on the well. Test pressures shall not be less than 600 pounds per square inch nor greater than 1,500 pounds per square inch, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department.

If a drop of more than ten percent of the casing test pressure is recorded, the operator shall then run a caliper log and/or other appropriate well test to determine if the casing is defective and if corrective measures will be required before commencing any further operations. The results of the prescribed casing tests and any remedial work conducted shall be submitted to the Department within sixty days after completion;

(8) Class "G" cement shall be used in any casing cementing operations and shall contain a high temperature resistant admix;

(9) If changes to the proposed well completion program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;

(10) Approval by the Department of Health must be recieved prior to commencement of injection operations proposed in the KS-3 Well Testing and Injection Program;

(11) During the use of the well for testing, monitoring, production, and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;

(12) The Permittee shall submit to the Chairperson the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor with six months after completion of the well;

(13) A well completion report, an as-built drawing of the well, and the location of the well plotted on a U.S.G.S. quad scale map shall be filed with the Department within six months after completion of the well modification;

(14) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original conditon;

(15) This permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

MAR 4 1992
Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

MW-3

EASEMENT B

MONITORING WELL MW-1

SOH-1

CORE HOLE

EASEMENT A

KS-13

KS2

WELL PAD B

POWER PLANT

KS-9

KS-10

KS1

KS-11

KS1-A

PAD A

KS-8

KS-7A

PAD D

KS-7

PAD F

KS-4

KS-3

KS-6

KS-5

PAD E

LANIPUNA 6

MONITORING WELL MW-2

HGP-A SITE

TO POHOIKI

PROPOSED)

EXISTING)

OPOSED)

BOUNDARY

1000 FEET

VENTURE

MAP

N